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TELEPHONES AND THE BRITISH ASSOCIATION.

TELEPHONES were more than usually in evidence at the British Association this year, two papers being presented, one by Mr. A. R. Bennett and the other by General Webber. Mr. Bennett's paper was designed to show why the United Kingdom, "with its preponderating commercial importance and unparalleled spirit of enterprise," was "only tenth" on a list which he had prepared, "instead of first." The answer was obtained from a study not exactly of the list, but from certain arbitrary observations, called "characteristics of management," which were attached thereto. It need hardly be said that the statistics fit in exactly with the conclusions—so much so, that we are disposed to regard the paper as belonging rather to Section F than to Section G, and we think it might be re-read with advantage at a future meeting, under the title, say, of "Some Lessons in the Preparation of Statistics, and the drawing of Conclusions therefrom."

In presenting statistics, one of the first questions which would naturally arise is the area from which they should be gathered. Mr. Bennett limits his to Europe. Considering the care and trouble expended by Mr. Bennett in the presentation of his numerous figures, it may seem a little ungrateful to complain that there are not still more. But we ought to remember that the use of the telephone is not confined to one quarter of the globe, and that there are sometimes greater similarities of circumstance between distant countries than near neighbours. However, Mr. Bennett limits his field of observation to Europe, and the result of it is that, the United Kingdom has the mortification to find herself only tenth on a list of which Norway is first. Who knows but that some preponderatingly important and unparalleledly enterprising Briton, who has now to hide his diminished head at the pre-eminence of Norway, might not be glad to hear that, after all, Norway with one telephone to 144 inhabitants must take second place to New Zealand with one in 120. (Report Telephone Service, p. 215.) Of course, we do not suggest that it would be so reasonable to make a comparison between the United Kingdom and the United States as between England and Finland, for instance, but if the United States were included in the survey, they would easily find a place in the first group, and we are afraid that the characteristics of management would cause a rather serious disturbance in the "conclusions." From these instances it will be seen that a little wider area for the selection of statistics would have prevented the presentation of plausible conclusions to account for conditions which any thoughtful observer would see must have some deeper seat. But even as they stand, the figures suggest further inquiry. The thoughtful observer might, for instance, have been struck by the fact that though there are but two Grand Duchies in the whole list of 19 countries,

both find themselves in the first group. The fact makes it obvious that Grand Duchies are conducive to telephonic development, and the reason would be worth seeking. We confess to ignorance of the internal economy of Grand Duchies, our knowledge thereof being limited to opera bouffe in which, for reasons of stage effect, a pre-telephonic era is usually represented. We simply suggest inquiry whether the official element still survives, and has anything to do with the numerous subscribers in proportion to population. One of the characteristics of a Grand Ducal theatrical army is, that it contains a large number of generals and a small number of privates. We note the same peculiarity in Grand Ducal telephone exchanges. In "The telephone systems of the Continent of Europe," the Grand Duchy of Luxemburg is credited with 85 switch rooms, whilst in the British Association paper it has but 59. The reduction has doubtless been made because 26 of the 85 consist of one subscriber each, and a telephone subscriber with an exchange all to itself would seem to be rather—well, Grand Ducal. The author attaches much importance to the number of exchanges in any country as an indication of its being well telephoned, and the proportion of switch-rooms to inhabitants is given in several instances. It may be well, therefore, to say that of the 59 remaining to the credit of Luxemburg, 36 have less than ten subscribers each. To regard the number of exchanges in any country as a measure of its telephonic development is a startling proposition. It leads to the conclusion that the best telephoned country is that which has an exchange for each inhabitant, whilst as a matter of fact the best telephoned country would unquestionably be that which had all its inhabitants connected to one exchange. From Mr. Preece's evidence in the Parliamentary Committee's Report, (p. 147), we see that between 1884 and 1893 the subscribers in the United States increased from 123,000 to 232,000, the talks increased from 215,000,000 to 670,000,000, and the exchanges from 1,325 to 1,439. Supposing that we judged the increased development by subscribers, it would be measured at nearly 90 per cent., by utility or by talks at over 300 per cent., whilst by exchanges it would be under 10 per cent. Mr. Bennett seeks to arrive at certain results by figures which may mean exactly the opposite of what he intended them to mean. In the above case the increase in utility might have been very seriously affected by an increase in exchanges. What he wishes to show can only be done by separating the town from the country, and by defining, as he does in the case of France and Russia, that towns may be well telephoned whilst rural districts may be neglected. That is an entirely different classification, and may form the basis of enquiry upon more reasonable grounds than a meaningless comparison of Luxemburg and Dorset. We are decidedly averse to any hasty generalisation, but the most casual observation of the table would seem to indicate that an enquiry into the characteristics of the countries and the condition of other means of communication therein, would be the means of arriving at an answer to Mr. Bennett's question.

It is the neglect of rural telephony in England which is the theme of General Webber's paper. The simplest way to consider his proposal, is to ask "Will it pay?" Supposing that all the facilities required could be obtained, and General Webber were retained by the County Council of Suffolk to advise them in the matter, would he recommend them to expend £50,000 in establishing a network of telephonic communication, and if asked to substantiate his estimate of income, where would he get his data from? Each call office must bring in on the average 2s. per day for 309 days in the year. That is £30 18s. per annum. We have no information whatever of the results of call offices in England, but suppose we turn to one of the "well telephoned" countries of the Continent of Europe, which is considered to be fairly comparative with an English county, to wit, the Grand Duchy of Luxemburg. We are indebted for our information to Mr. Bennett's book. We learn on page 271 that there are 65 public telephone stations, and on page 275 that the receipts at public stations amounted to 3,816 francs for the year 1893. That gives 58 francs, or, say, £2 6s. per station per annum. We must guard against the assumption that the comparison is conclusive—circumstances may differ, but it is suggestive, for if the best comparison that can be brought to bear shows receipts of £2 6s., where General Webber needs £30, it is not surprising that, in his own words, neither the National Telephone Company nor the Post Office would ever dream of adopting such a development of the service as he has suggested. It is a somewhat curious coincidence that one of the directors—we believe one of the oldest directors—of the Telephone Company is also one of the members of Parliament for a division of Suffolk. We do not suggest for one moment that a director of a company is necessarily acquainted with the company's business, or that a member of Parliament is likely to look after the interests of his constituents; but, if General Webber's plan has reasonable elements of success, it does seem that both company and constituents have some reason to complain that the utility of such telephonic communication has not been earlier demonstrated.

There are some truisms in these papers concerning the advantages of prompt and easy communication, but for practical purposes it is necessary to discern the real relations of cause and effect, and to have a suitable application of means to ends. Rural telephony will, no doubt, come in time, but before public bodies can expend large sums on such means of communication, there must be some reasonable evidence that agricultural depression can be talked away on telephones. Mr. Bennett's evidence of what things can be done for is not exact enough. He says: "It cannot be said that such rates as are applied in Luxemburg do not pay." Why? Because "even lower charges are made remunerative"—in some other places. Now let us turn to p. 275 of Mr. Bennett's book. In 1892 the accounts showed a small surplus; but "unfortunately the working expenses for 1893 are not shown separately from those of posts and telegraphs." It is certainly more reasonable to suggest that the alteration in the accounts arises because the surplus has vanished, than it is to attempt to prove continued success in one place by the experience of some other places.

Magnetism.

PROFESSOR EWING'S papers on magnetism seem to serve as a mine for other investigators to delve into after new relations. The latest of these is one discovered by Professor Houston and Mr. Kennelly, who find that the relation between the maximum cyclic value of the induction and the residual value of the same is a linear one up to comparatively large values of the former. The result is an interesting one from the point of view of magnetic theory, although it has not much practical application. It would be worth while seeing if a similar relation holds between the maximum magnetising force and the coercive force in a set of cycles.

The Weak Point in Electrolytic Processes.

It is an unfortunate fact that the value of the electromotive force required for the electrolysis of a given compound, calculated from the known heats of combination, is very different from that which is found necessary in practice. This has led to much abortive research amongst the practical men, and has caused much perplexity amongst the theorists. It is clear that the electromotive force in practice is very considerably affected by such conditions as the changes which take place in the degrees of concentration and of temperature: moreover, secondary reactions have to be reckoned with. But even when we employ the corrected formulæ of Helmholtz and Gibbs, or the more recent modification which has been elaborated by Nernst, these changes cannot be accounted for satisfactorily. Illustrations may be found almost anywhere; but none is so convincing as that of the electro-deposition of copper. When this takes place between copper electrodes in copper sulphate the conditions are ideally simple, but when we apply the principle to the extraction of copper, electrolytically, a number of bewildering combinations arise. The weak point in almost every electrolytic process at present employed is the loss of energy which takes place owing to the evolution of hydrogen. Take, for example, two processes which admit of easy comparison, namely, the production of chlorine by the electrolysis of hydrochloric acid and the decomposition of hydrochloric acid by air, aided by the contact action of copper. In the electrolytic process we have hydrogen formed and going to waste in such quantities that only 50 per cent. of the electrical energy is made use of. Now, since only 12 per cent. at most of the energy of the coal used in this process is converted into electrical energy, we have, even under the best conditions, only 6 per cent. of it going to produce chlorine. This will be found to work out in such a way as to show that the electrolytic process consumes six and a-half times as much coal as does the other process which was named for comparison. It is clear that if only the hydrogen evolved could be made to combine with oxygen so as to produce electric current, decompose chemical compounds, and produce heat and light, an enormous economy would be effected. As long ago as 1839 Grove showed how this problem could be attacked; but, although Mond and Langer have met with considerable success in their researches on gas batteries, it remains practically unsolved to this day, so far as technical applications are concerned. F. Quincke (*vide Zeits. d. Vereins deutsche Ingenieure*, xxxix., p. 1) has recently discussed this subject very clearly; his opinion is, that success may be looked for in the invention of a practical gas battery fed with air and producer gas.

The Salaries of Municipal Electrical Engineers.

Mr. Raworth makes a most unnecessary apology for writing to us on the subject of the salaries of municipal engineers. We are so far in sympathy with Mr. Raworth's remarks, that we have frequently drawn attention to the inadequacy of the remuneration of resident engineers. There is something, but we fear very little, to be said, in favour of not burdening an undertaking with a heavy salaried officer in the early stages of its career; but the fact is, if you once start a man with a low salary, he seldom arrives at a fair competency. We share with Mr. Raworth the honour of a wide acquaintance with central station engineers, and we have at all times especially noted the untiring energy and conscientious zeal which they bring to their work, whether their pay be high or low. The electric lighting of a town is of immense importance to its inhabitants, and having regard to its future development, it is very necessary that the position of the electrical engineer be a secure one. Apart from the question of remuneration, the borough electrical engineer does not always receive considerate treatment at the hands of his employers. We are not saying anything against the members of municipalities, but they should not forget that borough electrical engineer is quite synonymous with gentleman.

The Brush Electrical Engineering Co., Limited.

Perhaps the largest contract for electric lighting ever secured in this country was that obtained by the Brush Company for lighting the eastern division of the City of London. Certainly, after the work the Brush Company did in forwarding electric lighting in the City, they deserved some reward; but their guerdon, we fear, has been but dead sea fruit. It does not often fall to the lot of an electric lighting company to achieve so remarkable a feat as to lose nearly £20,000 on a single contract, but such was the melancholy story told to the Brush shareholders on Monday. The statement was, however, so well given, that eventually the shareholders, like wise men, accepted the inevitable, and resolved to wait for better days. In the interests of the shareholders, Mr. Braithwaite exercised commendable caution in setting forth the relations with the City Electric Lighting Company. We imagine that he could have said a great deal more than he did, had the necessity arisen; indeed, considering the enormous losses that the company had sustained, and the inside knowledge that he possessed, Mr. Braithwaite's position could not have been an easy one to fill. It is impossible for us to enter into the relations of the two companies; there never was much to admire in the working of the City Electric Lighting Company. They are fortunate in possessing the finest lighting area in the world, and this, combined with the unwarrantable keeping up of the price of electric energy, has, no doubt, done much to nullify the effects of bad work. No matter what may be the real cause of the loss in the Brush Company's financial year, the board of directors and managers are to be congratulated on the manner in which they have tided over a bad time.

Electric Lighting in Spain.

Of all continental countries, Spain seems to possess less enthusiasm in electrical matters than any other. We repeatedly hear of various districts in that country where the municipality or private bodies invite tenders for an electric lighting installation, but there the matter seems to stop, for no replies are received in response to the invitation. The lack of energy for which Spanish folk have long been conspicuous, is very apparent in that not a single Spanish contractor makes an offer. It seems curious, also, that foreign contractors do not make an effort to secure the business which is going begging. We can only think that they never hear anything of the matter until it has been shelved again by the originators of the proposal, or there is the possibility that the Spaniard's reputation and business integrity are such that contractors do not care to undertake any risks. It can hardly be expected that the smaller municipal bodies of Spanish towns will come specially to England for tenders; therefore, as there appears to be business to be secured, English contractors should make a point of going to them. The latest instance of this kind of thing was the little town of Deva, in Guipuzcoa province, where there was not a single tender submitted.

Electric Traction.

We have said so much with regard to the future of electric traction in this country, that we had almost made a pious resolve not to say anything more till something had been really accomplished. If, however, we read the signs of the times aright, there is going to be a big boom in traction before very long. This is distinctly good news to those who have waited, and almost prayed for, the development of electricity as a motive power. Mr. Blackwell was not far wrong at the B.A. when he declared that the tramways of this country need regenerating. It is to be sincerely hoped that the opening of the Bristol and Dublin lines will prove a useful object lesson to local authorities. If patriotic feeling goes for anything in these degenerate days, Englishmen may feel some gratification in knowing that in some of the details of the trolley in Bristol the system used on the South Staffordshire lines has been followed.

THE BRITISH ASSOCIATION.

THE DEVELOPMENT OF THE TELEPHONE SERVICE IN AGRICULTURAL DISTRICTS.

By Major-General Webber, C.B., R.E., M.Inst.C.E.

(*Read in Section G, September 16th, Ipswich.*)

On April 20th, 1895, the *Times* published a letter on my subject, which I had written to them as follows:—

"The Telephone in Rural Districts.

"To the Editor of the *Times*.

"Sir,—May I occupy a few lines of your space in attempting to show that the telephone as well as the light railway may (in the words of the Queen's Speech) be 'found beneficial to the rural districts.'

"In many countries the telegraph (including the telephone) which is the handmaid of railways, has been their pioneer, often because the capital outlay required for its establishment is comparatively small.

"As the future fate of the telephone service of this country is at the present hanging in the balance, it seems an opportune moment to draw attention to the question from the point of view of the 'continued seriously depressed condition of agriculture.'

"The county is the unit of area with which I have studied the subject, and the district round each market town is the natural site of an exchange system, with inter-communication between market and county towns.

"Some of the advantages of a complete telephone service to the dwellers in the rural districts of a county, through the establishment of a call office in nearly every parish, can be easily realised.

"To the farmers—the being able to converse with salesmen and customers at the market towns, saving journeys, and avoidable movement of stock and produce. To the village tradespeople—the facility of promptly replenishing small stocks. To the inhabitants—the power to converse with the shopkeepers in the market towns for their larger purchases, thus keeping trade within the locality. To the dealers in perishable articles, such as milk and fruit, the value of the advantage is not easy to compute.

"The distribution of labour and material to meet demand would be better guided and expedited than existing means of communication admit of. Fire engines and ambulance aid could be promptly summoned to places however remote, and, lastly, the administration of the executive duties of the County Council would be enormously helped.

"I have worked out a scheme for such a rural telephone service in one of the purely agricultural counties, which has nearly 400,000 inhabitants, and a gross rental of nearly two millions, and the figures present a very hopeful result.

"The material used would be what military telegraphers would call 'light permanent line,' and of the character largely used in Europe for the telephone.

"Such a county would require 29 exchanges, and call stations at 415 villages and hamlets. The length of pole line required to be erected would be a little over 1,000 miles, and the length of wire to be run a little over 4,000 miles. These figures are exclusive of the lines from private premises to the exchanges, which might in time be reasonably expected to number 700 or 800.

"The capital outlay would be about £49,000, and the annual cost, including interest, sinking fund, maintenance, renewal working and management, would be about £12,000 per annum. These figures are based on cost price, as if the work was undertaken by the County Council. To cover this a charge of 2d. would be made for each conversation of five minutes within arranged areas, and this must amount to a daily average of takings at each call office of 1s. 11d.

"The value of the service to the county administration and the net result of the revenue from the private lines would be profit.

"How far such a scheme would fit into the existing postal telegraph system, or interfere with or help it, is more a question for the Parliamentary Committee, now sitting on the subject, than for your page.!

"Without any delegation from them, I venture to advocate the cause of the local authorities in the 120 counties in the United Kingdom.

"I remain, Sir,

"Your obedient servant,

"C. E. Webber."

and on May 14th, 1895, I was examined before the Committee of the House of Commons on the subject, and gave some details of the proposals contained in that letter.

It has occurred to me that as the suggestion, if carried out throughout the United Kingdom, whether by the Post Office or by local authorities, would involve a very large expenditure, that, from the engineering point of view, this section is an arena not unsuited to its discussion. I have therefore entirely revised the figures in detail, and prepared the map of the county of Suffolk, which is exhibited.

Neither the National Telephone Company (the monopolists for 15 years of the telephone in this country) nor the Post Office would ever dream of adopting such a development of the service as that which I have suggested. I therefore do not expect to receive support from either of those bodies from the revenue and commercial point of view.

As a natural consequence of the meeting of the British Association this year being held at Ipswich, I have selected the county of Suffolk as the most suitable area for an example of the proposed work.

The map of the whole county before you is on the 1-inch scale, and it will be seen that every sub-post office is marked on it with a blue disc, and that each office, which is also at present a telegraph office, is marked, in addition, with a flag.

The places at which, under my proposals, a telephone exchange office would be established, are distinguished by a red circle outside the blue.

At present the main telegraph lines throughout the county are, with one exception, placed on the railways; that exception being the road line from London to Lowestoft, which was erected on the main road which lies throughout its length contiguous to the main line of railway of the Great Eastern Railway Company. This line I had the honour to lay out and construct in 1870, being then divisional engineer of the postal telegraphs in this part of England. The other telegraph lines in the county are almost exclusively short branches from the railways to the pos' offices at the large and small market towns, numbering altogether 105.

The number of places at which, under my proposals, it is intended to establish telephone call offices, in addition to those where telegraph offices exist, is 246. This makes a total of 351 places in the county of Suffolk where telephone communication could be had by the public (*vide* Appendix).

The places included in the above 351, at which exchanges would be established are—

Lowestoft,	with public connections.		
Beccles	"	"	"
Bungay	"	"	"
Halesworth	"	"	"
Southwold	"	"	"
Saxmundham	"	"	"
Aldeburgh	"	"	"
Wickham Market	"	"	"
Framlingham	"	"	"
Woodbridge	"	"	"
Felixstowe	"	"	"
Eye	"	"	"
Debenham	"	"	"
Bateadale	"	"	"
Haughley	"	"	"
Stowmarket	"	"	"
Needham Market	"	"	"
Thetford	"	"	"
Brandon	"	"	"
Mildenhall	"	"	"
Bury St. Edmunds	"	"	"
Newmarket	"	"	"
Haverhill	"	"	"
Clare	"	"	"
Long Melford	"	"	"
Sudbury	"	"	"
Hadleigh	"	"	"
Nayland	"	"	"
Ipswich	"	"	"

29 exchanges in all.

These exchange systems will require the construction of 524 miles of new line along roads not already occupied with lines by the Post Office, coloured green on the map. They will also require wayleaves for wires on 253 miles of existing telegraph lines along roads already occupied by the Post Office, coloured blue on the map.

In addition, it is proposed to obtain wayleaves on 37 miles of existing poles on the railways, coloured red on the map. Giving a total of 794 miles of lines to form the systems.

For obvious reasons it is proposed to have only one wire with earth returns for each circuit; but it is also proposed, where interchange between exchanges is required, and in special cases to prevent the effects of induction, that such shall be effected by means of twin wires.

On the map the lines alone are shown by a single line of the green, blue, and red, as the scale will not allow of the individual wires being distinguished.

It is not suggested here as a necessity that the existing Post Office poles should be used. A new pole line could be erected along the same road; but it is obvious that where there is space to carry additional wires, it could be made mutually advantageous to use them. For this user the county telephone system would pay an annual wayleave at the rate of 10s. a mile of conductor, single or twin.

The number of wires, including trunks, for which space will be required on a pole, whether it is an existing one, or one especially erected, varies from one to eight. The average will be five. This will require a total mileage of 3,970 new wire.

In the construction, a much lighter material can be used than that to which we are accustomed by Post Office use.

The poles, which will be of a size to be procured largely in the district, may or may not be creosoted. Their cost will average in either case £12 10s. a mile, and £20 a mile when erected complete with brackets, insulators, strutts, and stays.

In some out-of-the-way districts the Post Office allow themselves to limit the poles to 17 to 18 to the mile, but I should provide 22 to 25.

The insulators would be small single shed, as used in France and Switzerland, having a bent shank to screw into the timber. They may be fixed within 9 inches of one another, measuring vertically on the pole.

The conductors would be of No. 18 bronze, and costing £5 per mile when "run."

In case the Post Office should demur to the call boxes being placed in sub-offices, there is little doubt that small shopkeepers would be found willing to provide the call office and take charge of it, with a payment of, say, 2s. 6d. a week and a percentage of the receipts after they have reached a minimum, say, of 2s. a day, added to which would be the advantage of attending the circuits of private sub-

scribers. No skilled labour is required, and the necessary attention and attendance could be given by the youngest girls of a family. On the Continent of Europe, the village schools arrange that boys and girls shall have leave of absence in turn for such duties. When *we* come to our senses on the subject of withdrawing country children from rural occupations to sit all day in a school, the same thing would be done in Suffolk.

The cost of the system for Suffolk may be estimated as follows:—

29	Exchanges at an average of £151. This provides for 50 per cent. spare connections	£4,375
351	Call stations, at an average of £7 10s.	2,633
524	Miles of new lines, at £20 per mile	10,480
3,970	Miles of wire run on new and existing poles, at £5 per mile, with double conductors in the case of 950 miles	23,820
Add $\frac{1}{10}$th for contingencies...		4,130
	Total capital cost of the system	£45,435

The receipts or takings of all kinds will have to provide for the following annual expenditure and allowances, so that if the system were established by the County Council, there should be no charge on the rates:—

Interest and sinking fund on £45,500 at 4½ per cent. ...			£1,933
Renewal fund—			
Of poles at 7 per cent.	£733		
Of wire and instruments, at 3 per cent. ...	238		
			971
Private wayleaves (estimated)			524
Wayleaves on existing poles for each double or single conductor at 10s. a mile			675
Management			300
Maintenance—			
Salaries and wages—			
1 Inspector	£200		
1 Assistant inspector	150		
4 Linemen	280		
Small stores and sundries	250		
			880
351 Call offices, rent, attendance, including small stores and sundries, average £9			3,159
29 Exchanges—			
Salaries	£80		
Rent	12		
Small stores and sundries	10		
	£102	=	2,958
Add 5 per cent. for contingencies...			573
Total annually			£11,973

Say £12,000 a year.

The greatest portion of the above payment for wayleaves on existing poles would be a clear gain to the Post Office revenue. The cost of private wayleaves might be much less than the amount estimated, if the lines are the property of the County Council.

The value of the service to the administration of the County I place at £350 per annum. It will thus be seen, after also deducting £900 for profit on private lines, the most that must be earned is £10,660 per annum.

That individual occupiers of all ranks would be found ready and willing to pay for the convenience is highly probable, but its application would be limited, owing to the great facilities proposed to be afforded at the public call offices.

One of the chief inducements to the possession of a private line to one of these exchanges would be the facility given for communication with the postal telegraph system of telephone lines. Naturally a Post Office license for such a telephone system in the County of Suffolk would include the obligation to connect up with all the postal telegraph offices in the county.

In most cases it may therefore be held that the subscriber will wish for a service necessitating two wires.

Estimating the average distance of a subscriber's house from the exchange at 2½ miles and that 1½ miles of this will be on special poles, and that each will require a twin wire conductor, the outlay on each private subscriber's line would be on an average £71.

With this outlay, a profit of £3 out of an £8 annual subscription is not an over-estimate, the outgoings, including a special extra payment at the exchange, for services for each such private subscriber, which would be an increment to the wages of the call office attendant.

It is not too much to expect that 300 or 400 private subscribers in one large county like Suffolk may be expected in time, whose subscriptions would yield a net revenue of £900 to £1,200 per annum.

The next aspect of the question, from the County Council point of view, is the value of the assistance given to the conduct of county business. I have consulted several chief constables, and they are all unanimous in testifying to the great help such means of communicating about the county would afford to their department, both as regards efficiency and economy.

The same remarks apply to the departments of sanitation works, health and education.

No small facilities would be given to all operations affecting the exercise of the suffrage at elections for all purposes.

The various district and parish councils would be more in touch with one another, and with the supreme county authority. To all this service I have attached the exceedingly low valuation of £350 per annum.

As regards trade, it is not too much to say that saving of time is the essence of the acquisiton of profits, and that if this can be achieved at a very small cost in proportion to the service rendered, an infinity of processes in the smaller industries and trades can be helped, on a scale which the telegraph and telephone—the most important means of saving time—have never yet attempted.

Light railways, with which I have dealt in another paper read before this Section, may or may not be financially possible to take the place of the present means of transport in agricultural districts; they are a substitute for something already in use, but such a system of telephony as I have described is an entirely new development of a means which may prove a first necessity of the daily business life of the small cultivator and village tradesman, as it must evidently be in that of the farmer.

I submit the following for consideration, as indicating the uses to which the telephone may be put in rural districts.

The being able to converse with salesmen and others at the market towns would save journeys and premature movements of horses, beasts and produce.

The power of speaking with another farmer or a bailiff at another farm in another village, on questions of exchange of produce, labour, transport, also as to meteorological conditions. The village tradesman would have increased facilities for meeting wants that otherwise require a journey of himself or of his customer.

Purchases in the market town from the superior tradesman could be made by conversation, and perhaps the expenditure of money be kept within the locality, instead of sending to London or the large towns for small articles of consumption.

All that appertains to the service of stallions and bulls would be more simply settled by conversation than by letter.

Questions regulating the accumulation and transport of perishable food material, such as milk, would be assisted, and time and occasional confusion and loss would be saved.

Farm labour, male and female, would have opportunities of information as to demand and supply, and market town hirings would be diminished.

Besides this, social gatherings amongst all classes, to the advantage of out-of-the-way districts would be promoted, indirectly checking the migration of the rural population to the towns; and the operation of lending libraries would be assisted.

Naturally, the question of the early arrival of medical aid and ambulance assistance, and in case of fires, occurs to anyone who considers the subject.

Now as to the charge to be made for each use of a call office: the audience may be surprised to hear that I propose to put this at 2d. for three minutes, to cover the use of one exchange, with a small addition, say of 1d., if it is necessary to communicate through two or more exchanges within the county. The rates external to the county would be governed by those over the postal telephone trunk lines.

It is only necessary for the gross takings at the 351 call offices to be on an average of 2s. per diem for 309 days in the year, in order to cover the £10,660 outgoings already calculated above. I should be inclined to keep the system open for 16 hours out of the 24, but that is a detail, and may vary according to local circumstances. Of course, by previous arrangement for official purposes, it could be kept open continuously at a correspondingly increased cost for attendance. If the takings average above 2s., I should propose appropriating a part of them to a fund to be used as premiums for good service of the employés.

For the messenger service required to summon a correspondent and bring him to the call office, a special charge per quarter of a mile would be made, and need not exceed 1d., to be paid at the time by the person called.

It is not to be expected that the Post Office could look on with perfect equanimity at the realisation of such a scheme as this, because they will at once apprehend a lessening of revenue at their 105 County of Suffolk telegraph offices. I have no information as to the number of forwarded and received messages at those offices, but it would be interesting if the Post Office will give these figures for the year since the adoption of the 6d. rates, both as regards what might be called local and external traffic.

I think it is highly probable that the quantity of local messages only would be affected, and that there would be a compensating increase of external telegraph messages.

Besides, as the local telephone exchanges would be in communication with the telegraph system, there would doubtless arise a very considerable correspondence by telephone over the Post Office trunk wires, which would be a new and hitherto untapped source of revenue.

There is also a compensation in the wayleave rental of £675 a year, payable to the Post Office, to which I have already referred.

I would observe that Post Office objections, if any were made, on account of loss of revenue through a decrease of correspondence between, say one county and another, or between the county towns and the Metropolis, should such arise, might lead to letting light in on a question which I believe has not been sufficiently considered, namely, whether the wide extension of telegraphic and postal facilities in the last 25 years may not be one of the indirect causes of what is called agricultural depression. For while these particular facilities have been increased, those for the economical conveyance of persons and goods have shown no corresponding advance. By this, what might be called the due balance, of means for advancement of local trade, has not been secured; and it may very possibly be shown that through such an apparently trifling absence of adjustment, the great diversion of trade for the supply of London from the country districts of England to the Continent, has been assisted.

I do not think we need sympathise with the departmental objections of the Post Office to the loss of revenue on what might be called the "Private wire branch." Ever since the transfer of the telegraphs

to the Government the charges for such service have been practically prohibitive.

Some idea of the exorbitance of these rates is given by the fact that, if such a system as I have described was established in Suffolk by the Post Office, and rented to the County Council to work for the use of the inhabitants, the rent alone for the lines and stations, at the Post Office published rates, would be at least £18,658 a year for what, in my estimate, costs £5,388 a year; and each private subscriber would have to pay on an average about £20 a year.

As regards what the National Telephone Company have done in Suffolk up till now, I can obtain no information, although I have applied for the information to the company.

I hope that it will be realised that what I have described is entirely practical and feasible. I have not allowed in my estimates for a contractor's as well as an engineering profit, but the funds I have detailed for are amply sufficient; also, that if undertaken by the local governing bodies great benefit would arise without any charge on the ratepayers.

It is hard to believe that the system would not become very popular in the use, and in the interim, say, for the first three or four years, the Post Office might well forego any royalty, seeing that the late and present Governments have expressed such warm sympathy with the conditions of the greatest industry in the land.

As I have suggested, it seems reasonable to believe that the facility afforded of being able to converse between county neighbourhoods, and between them and urban and suburban districts, will do much to check migration to the large thickly-populated centres. If you annihilate distance for purposes of conversation, may you not do away with many an excuse for accusing country districts of being "too dull to live in"?

SOME LESSONS IN TELEPHONY.

By A. R. Bennett, M.I.E.E.

(*Read before Section G, September 16th.*)

In 1845 Mr. J. C. Bourne, in his history of the Great Western Railway, wrote: "It is a well-established truth in the history of trade and commerce that the traffic between two cities or countries will increase in proportion to the facilities of communication afforded, or to the speed, security, and cheapness with which such communication can be effected."

The truth of this proposition had been demonstrated before Bourne's time in respect to common roads and waterways; since, experience has shown that no town can prosper unless it be connected with the railway system of the country. In the beginning, several towns, by spending large sums in opposing Railway Bills, succeeded in keeping off the main lines of communication, but the magnitude of the error has long since been manifest, and great efforts have been made, not always successfully, to repair it.

Bourne's axiom may now-a-days be admitted to embrace telegraphic and telephonic facilities, for places wanting these are at a great disadvantage as compared with more fortunate neighbours. If commerce may be held to constitute the life-blood of a modern nation, roads, railways, and waterways are the arteries through which this blood is conducted, while telegraphs and telephones may be compared to the nerves which feel out and determine the course of that circulation which is a condition of national prosperity. Given two nations, equal or nearly so in natural resources and in the talents and industry of their inhabitants, that one will succeed the better in commerce which possesses the most extended and cheapest facilities for transport and general intercommunication.

It has recently been demonstrated that the United Kingdom is deficient in at least two of these essentials—railways in their branch or feeder form, and telephones, which are the natural feeders of the telegraphs. Why this is so may best be discovered by ascertaining by what means, technical or economical, those nations which have most conspicuously outstripped us have attained their superiority. For the purposes of this paper, in which is considered the telephonic branch of the question, the countries of Europe have been divided into three groups: (1) well telephoned; (2) indifferently telephoned; (3) badly telephoned.

A country may most properly be said to be well telephoned when its smaller towns and villages enjoy facilities, for the existence of a few large exchanges in the capital and chief towns does not entitle it to that distinction. For instance, France, Russia, and Portugal all possess good exchanges in their capitals, but are nevertheless badly telephoned as a whole, since their smaller towns and villages are excluded from the circle.

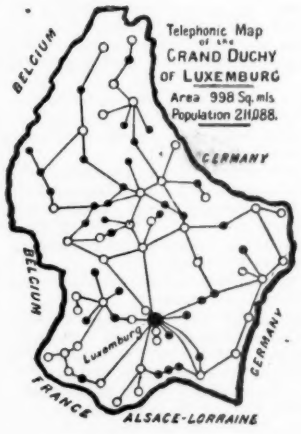
On the other hand, we find that the Grand Duchy of Finland, under the same crown as Russia, but enjoying a different system of administration, is distinctly well telephoned. Its area exceeds that of the United Kingdom, although the greater part of its surface consists of lake, forest, and waste; its staple industries are fishing and agriculture, yet a telephonic map of Finland discloses a veritable network of lines. All the towns and many of the villages possess exchanges, while the capital, Helsingfors (population 65,000), is one of the best telephoned cities in the world. Last year there were 198 exchanges in Finland, or one to each 12,626 inhabitants. In the United Kingdom there were but 578 exchanges, or one to each 65,537 inhabitants. In proportion to its population, Finland had therefore more than five times as many centres of telephonic activity as the United Kingdom. Even the people of the Aland Islands, in the middle of the Baltic, find a telephone exchange so well worth paying for at the rates which are found remunerative by the exploiting company, that in Mariehamn, the capital, there is an exchange telephone to every 13 inhabitants. In fact, Mariehamn is entitled to the distinction of being the best-telephoned town in the world. Another Finnish town, Viborg (population 22,344), has an exchange telephone to every 33 inhabitants, and other towns have one to 36, 37, 39, and 40.

Norway is, however, the best-telephoned country on the whole. It has a population of 2,000,000, and has little to rely upon in the world's struggle but agriculture, forestry, and fishing. Seventy per cent. of its total area is uncultivable, and another 24 per cent. is forest. It has but half-a-dozen towns, the bulk of the population residing in widely-scattered villages. Yet it possesses no fewer than 256 telephone exchanges, or one exchange to each 7,812 inhabitants—more than 8½ times the number in the United Kingdom in proportion to population.

Sweden, which takes the second place in the list of well-telephoned countries, possesses greater resources than Norway. It has a population of not quite 5,000,000, one-half of which is dependent on agriculture. Eighty per cent. of the people live outside the towns. A radius of 43½ miles round Stockholm, equal to 5,945 square miles, is unquestionably the best telephoned bit of country in the world. Almost every village possesses two competing telephone exchanges, while rival systems of trunk lines place the whole of this large area in practically instantaneous communication.

Denmark, with its population of 2,250,000, and its staple industries of agriculture and dairy farming, takes an honourable place, having 152 telephone exchanges within its borders, or one to every 14,639 inhabitants.

The four foregoing countries form a class by themselves. Their telephonic development has been due almost exclusively to companies and co-operative societies. In Sweden the State has of recent years assumed an important position in respect to telephony, but its proceedings and tariffs have been based upon the previously established procedure and tariffs of the companies whose systems it found in operation. In the two next instances the development attained is due wholly to the fostering care of the respective States.



Switzerland has a population of 3,000,000, which is served by 155 telephone exchanges, or one to every 19,355 inhabitants. All its towns and many of its villages possess telephone stations and are connected by trunk lines. The Grand Duchy of Luxemburg contains 998 square miles, which is also precisely the area of Dorsetshire. The respective populations are 211,088 and 194,517. Agriculture is the staple industry of Luxemburg, as it is of Dorset. We find, however, that while Luxemburg possesses 59 telephone switchrooms within its borders, or one to each 3,577 inhabitants, Dorset has only three—Dorchester, Weymouth, and Poole—or one to each 64,839. Luxemburg had last year 1,315 exchange lines; Dorset, at the present moment, possesses about 70. In Luxemburg, there is an exchange telephone to every 160 souls; in Dorset, one to 2,778. Every town and village of Luxemburg is in telephonic communication with the capital and with each other. The accompanying maps

exhibit the different stages of development attained in these two equal areas. And yet many counties are worse off than Dorsetshire is.

This completes the list of the European countries which are well telephoned, and constitute Group I. The least favourable result in this group is 328 persons per exchange telephone. A considerable jump must be made in order to reach the best country of Group II. This is the Imperial German Post Office territory, which comprises the whole of the German Empire except Bavaria and Wurtemberg. Within its limits there was last year one telephone to every 449 inhabitants. It is noteworthy to remark that the comparatively good position taken by Germany is due to the fact that Berlin, Hamburg, Frankfort-on-Maine, and other chief towns possess very large exchanges, Berlin and Hamburg being amongst the largest in the world, even Hamburg (population 622,530) having a larger number of subscribers than London (population 5,600,000). But the small towns and villages are not developed, and rural intercourse by telephone is practically non-existent. The reason is that the German Post Office has a uniform tariff, applicable equally to the capital and to the smallest village, which, although reasonable for Berlin, is prohibitive for the country folk. The results obtained in Bavaria and Wurtemberg are not dissimilar. Wurtemberg has a lower initial tariff than the Imperial Post Office, but is hampered with restrictions which operate against rural development.

The United Kingdom comes next in order of merit, with one exchange telephone to every 636 persons. These figures, like the continental ones, refer to last year. The ratio has improved since then both at home and abroad, but the relative positions remain unchanged.

Holland and Belgium complete Group II. A wide gap intervenes between this and Group III., or badly telephoned class. The best country of this is France, with one exchange telephone to every 1,432 persons; and the worst is Russia, which can only show one to each 13,102 inhabitants.

The foregoing facts are presented in Table A, which also gives the leading characteristics of the management in each country.

The questions naturally arise, "To what causes are such vast differences in development to be ascribed?" and "Why is the United Kingdom, with its preponderating commercial importance and unparalleled spirit of enterprise, only tenth on the list, instead of first?" A study of the table supplies the answer. It shows that telephonic development is proportional to the prevalence of the following features: (1) low rates; (2) local management; (3) facilities for rural intercourse; (4) competition.

At least three of these are characteristic of each of the six countries which compose Group I. On the other hand, they are almost completely absent from Groups II. and III., the leading characteristics of which are (1) high rates, (2) centralised management, (3) neglect of small towns and rural districts, (4) absence of competition.

TABLE A.

Order of merit.	Country.	Population.	Number of exchange telephones.	Number of persons to each exchange telephone.	Characteristics of management.
	Group I.				
1	Norway	2,000,917	13,943	144	Very low rates. Local management of exchanges. Good rural intercourse. No competition.
2	Sweden	4,784,981	32,602	147	Very low rates. Local management of exchanges in part. Good rural intercourse. Competition.
3	Luxemburg	211,088	1,315	160	Very low rates. Central management, but with delegated control in some cases to local authorities. Good rural intercourse. No competition.
4	Switzerland	3,000,000	17,422	172	Ditto ditto ditto.
5	Denmark	2,185,335	10,325	211	Very low rates. Local management of exchanges. Good rural intercourse. No competition.
6	Finland	2,412,135	7,351	328	Very low rates. Local management of exchanges. Good rural intercourse. Competition.
	Group II.				
7	Imperial German Post Office Territory	41,796,966	93,131	449	Fair rates for urban subscribers in large towns; high rates in small towns. Highly centralised management. Bad rural intercourse. No competition.
8	Bavaria	5,594,982	12,400	451	Ditto ditto ditto.
9	Wurtemberg	2,036,522	4,430	459	Low rates for urban subscribers, but with regulations tending to restrict suburban and rural intercourse. Centralised management. No competition.
10	United Kingdom ...	37,880,764	59,569*	636	High rates, with regulations unfavourable to development outside towns. Local management in part. Practically no competition.
11	Holland	4,669,576	7,263	643	High rates in three chief towns; low rates elsewhere. Management chiefly centralised. Bad rural intercourse. No competition.
12	Belgium	6,136,444	8,757	700	High rates in large towns; low rates of recent origin in small towns. Centralised management. Indifferent rural intercourse. No competition.
	Group III.				
13	France	38,343,192	26,772	1,432	High rates; subscribers also pay capital cost of their installations, except in Paris and Lyons. Centralised management. Bad rural intercourse. No competition.
14	Spain	17,800,000	10,984	1,618	High rates in large towns. Recently introduced reduced tariff for smaller towns. Local management. Bad rural intercourse. No competition.
15	Austria	23,895,413	14,574	1,640	Fair rates, but subscribers pay capital cost of their installations. Centralised management. Bad rural intercourse. No competition.
16	Italy	30,535,848	12,067	2,530	High rates in large towns, except in Rome, where competition exists; low rates in Rome and in small towns, but under strict Government supervision. Bad rural intercourse. No competition except in Rome.
17	Hungary	17,463,473	5,563	3,139	High rates in towns; very low rates in villages, but combined with regulations which tend to restrict communication between towns, suburbs, and villages. Partly local management. No competition.
18	Portugal	5,000,000	1,483	3,371	Exchanges only in Lisbon and Oporto. Fair rates. No rural intercourse. No competition.
19	Russia...	97,151,789	7,415	13,102	Highest rates in Europe in chief towns; high rates in smaller towns. Partly local management under Government rules. Bad rural intercourse. No competition.

* Company, 58,367; Post Office, 1,202.

The operation of low rates and competition in the direction of development is easily understood, but that of local management is not so obvious. Its importance, however, is great. No two places are precisely alike in commercial, social, or topographical features, and telephonic arrangements which suit one neighbourhood admirably are not appreciated in another where other conditions call for other plans. To meet the wants of a locality fully, it is necessary that its character should be thoroughly understood at the headquarters of management, and this, when exchanges are numerous, is not attainable. On the other hand, a Board or council of local men know the requirements of the community exactly; hence the superiority of the results presented by the Scandinavian local companies and co-operative societies. Wherever management is centralised, uniformity is aimed at as a means to economy and of saving trouble, and what appears good in the capital is apt to be imposed on every other town.

In the countries of Group I. special attention is given to small town and rural development. In Switzerland a village council, commune, or other local authority may establish and manage a

telephone station in one of its own buildings, and work it with its own employees, simply paying to the State the ordinary subscription of £4 16s. for the first, £4 for the second, and £3 4s. for the third and subsequent years, for the privilege of a junction with the general telephone system of the country. Such stations, of which there are 129 in Switzerland, are available for the despatch and receipt of written telegrams as well as of telephone messages. The local authority is authorised to collect a small surcharge on the ordinary tariff to cover expenses incurred for wages, office, and the annual payment to the State.

In Luxemburg a similar system prevails, and is taken advantage of by 34 local authorities. The annual payment to the State for the connection of the municipal station to the general system of the country is uniformly £4 per annum.

France has adopted a similar system, but with a much higher scale of charges and with restrictions which appear irksome to the local authorities, since in 1894 only 10 municipal stations existed in the whole of France.

In the Scandinavian countries and Finland, local management has had even freer play, with the highly satisfactory result disclosed in the table. The third town of Norway, Trondhjem (population 30,000), is worked by the municipality most successfully at very low rates.

On enquiring in what manner circumstances differ so gravely in the United Kingdom as to preclude the possibility of small towns and rural communities availing themselves of telephonic communication, it appears that, apart from the want of local control and competition, the inelasticity of the present system of tariffs, which was originally invented for towns, is much to blame. In towns distances are short, and subscribers, if the switchrooms are properly distributed, have seldom to pay more than the unit charge, but in country districts distances of several miles must often intervene between the subscriber and switchroom, and as the annual rental exacted increases rapidly with the distance the charges become piled up by the extra mileage beyond the means of the majority of the population. What is wanted is the application of the Austrian (which, with some modifications, has also been adopted in Luxemburg) system of tariffs, under which all subscribers, whatever their distance may be from the switchroom, are put on an equality as regards annual subscriptions, the only difference being made in the initial payment on joining the exchange, which varies with the length of line required, the object being to reimburse the owners of the exchange system once for all for the additional cost of the extra mileage. In Austria the annual subscription is the same for any distance up to 15 kilometres (9¼ miles). In Luxemburg the annual subscription, provided the distance of the subscriber from an existing route of wires is not greater than 1½ kilometres—which is seldom the case, so numerous are the lines—is always £3 4s. per annum, which covers all charges for service and maintenance, and confers the right to talk all over the Grand Duchy, which measures 44 by 30 miles. If a subscriber is situated outside the free radius which surrounds every switchroom, he makes, on joining the exchange, an initial payment, designed to cover the cost of the line which intervenes between the free radius and his place. This is charged at the rate of £4 per kilometre only, and the payment may furthermore, if desired, be spread over five years. If located within the free radius, the subscription is simply £3 4s. per annum without an initial payment. Comparisons are often instructive, and it will be interesting to examine the differences resulting from the application of this system and that which prevails at home.

In Luxemburg a subscriber located five miles (eight kilometres) from the boundary of a telephone area (provided he is not more than 1½ kilometres from an existing line) will pay:

A compensation for extra distance, £5 × £4 = £20 in one payment, or, if he chooses, divided into five annual payments of £4, and thereafter an annual subscription of £3 4s. If 15 kilometres (9¼ miles) away he pays £15 × £4 = £60 down, or £12 for five successive years at his option, together with an annual subscription of £3 4s. He may be taken to pay £15 4s. for the first five years, and £3 4s. per annum for all time thereafter. The British Post Office charge £14 per annum per mile, so that a subscriber five miles from a switchroom would be charged £70 per annum in perpetuity, while one 9¼ miles away would pay no less than £134 per annum. The National Telephone Company's charges would be more than this in the metropolitan area and less in the provinces, but always, as experience has amply proved, prohibitive.

The different results aimed at in the United Kingdom and in Luxemburg need, therefore, create no surprise. They are simply examples of cause and effect. It cannot be said that such rates as are applied in Luxemburg do not pay. Accounts and balance-sheets have recently been published* which prove that even lower charges are made remunerative by local companies and municipalities in Holland, Denmark, and Norway.

The telephonic development attained in the Aland Islands, the entire population of which numbers but 18,000, has been mentioned. What have we to show at home of a corresponding nature? The Isle of Man (population 55,608) has one exchange. The Isle of Wight (permanent population 78,672, which is much increased in summer), containing seven or eight flourishing towns, possesses no telephonic facilities whatsoever; and the Channel Islands (population 92,234) are in equally bad case, although both Jersey and Guernsey are places in which a good telephone system would be of the utmost value, owing to the necessity the farmers are under, especially at certain seasons, of maintaining good communication with the ports, St. Helier's and St. Peter's. Exchanges in these towns alone would be next to useless: it is necessary to bring the outlying villages and scattered farmsteads into connection with them, and as this would necessitate many lines of from two to five miles in length, the existing tariff both of the Post Office and National Telephone Company are prohibitive and impracticable in a ludicrous degree. But an intelligent application of one or other of the Norwegian, Finnish, or Luxemburg methods would speedily cover the islands with telephone lines, and that with profit both to the servers and the served. The cases of Jersey and Guernsey have, unfortunately, their parallel in most of the country districts in the three divisions of the United Kingdom.

One of the Norwegian companies—the Drammens Uplands—affords a striking example of profitable rural telephony. The area for which it holds a concession from the Government extends over five counties and measures 143 miles from north to south, the most important places served being the villages called Kongsberg and Hönefros. At the end of 1894 the company possessed 24 switchrooms, 292 subscribers, 478 miles of poles, 1,553 miles of lines, including 671 miles of metallic circuits. Its annual subscription, which covers a line not exceeding two kilometres in length, and the right of free conversation over the whole of the five counties, is only £5 11s. 1d. Its capital account stood at £9,815; its receipts from all sources for the year amounted to £2,332; the net profit was £752 and the dividend 6 per cent. This dividend has been paid regularly during the five years of the company's existence, and a deterioration and reserve fund built up besides. These are facts which should surely plead against the present era of telephonic stagnation.

The technical features of the continental systems are, as a rule, best where the tariffs are lowest and the extension of communication greatest. The conditions laid down by the author in his paper on "The Telephoning of Great Cities," read at the Cardiff meeting of the British Association in 1891, as being necessary to a well-ordered exchange, are fulfilled more nearly in Sweden than elsewhere, especially by the General Telephone Company, which operates in Stockholm and a radius of 43½ miles around. Metallic circuits are universal; special attention is given to prompt switching, and Stockholm is divided into eight nearly equal divisions each containing a switchroom. The prompt and economical addition of new subscribers is thus rendered easy. The speed achieved in switching is that stated in the paper to be practicable and proper in a good exchange, viz., 10 seconds. The countries comprising Groups II. and III. are, with some exceptions, technically behind those of Group I. The reason lies on the surface. The conditions which prevail in Group I. bring about rapid extension; rapid extension involves the solution of problems which do not present themselves while exchanges are in their infancy, and the solution of such problems evolve superior engineers.

* "The Telephone Systems of the Continent of Europe." Longmans, Green & Co., London and New York.

A PORTABLE MAGNETIC FIELD TESTER.

By Prof. W. E. Ayrton, F.R.S., and T. Mather.

(Read before Section A, September 17th.)

In June 1892, the authors described a portable ballistic galvanometer of the moving coil type, before the Physical Society of London,* but owing to delay in the manufacture the instrument was not ready in time to be shown at the meeting. Since that time many experiments have been carried out with the instrument then described, and the galvanometer has been used to map out the stray fields of various dynamos and to explore the magnetic fields in the neighbourhood of switchboards of electric light stations.

This first instrument possessed several structural defects, but the most serious faults experienced were, first, inconstancy of zero, and, second, a considerable want of proportionality between quantity and swing—or strength of field and swing of the needle,—a proportionality which theoretically should hold for all angles of whatever magnitude. Eventually, both these difficulties were traced to magnetism in the suspended coil, a property which, although every care may be taken to prevent contamination of the material with iron, is very difficult to eliminate. After much experimenting, with a view to avoiding traces of magnetism in the suspended parts of moving-coil galvanometers, a satisfactory method was devised early in 1894, and a description of a reflecting galvanometer fitted with an improved coil appeared in the technical papers in the autumn of that year.† Meanwhile, an improved form of the portable ballistic galvanometer had been designed, in which the details of construction were considerably modified, so as to make the working parts more accessible, and an improved shape of coil was employed. For ballistic galvanometers

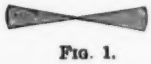


Fig. 1.

the best shape of the cross-section of the moving coil is not the same as that for a current galvanometer, for whilst a current instrument should have a coil whose section approximates to two circles touching one another, a ballistic instrument is improved by using a sector-shaped coil of narrow angle, as shown in fig. 1.

The instrument as now made is shown in fig. 2, whilst fig. 3 gives a sectional plan. A circular base provided with levelling screws carries a C-shaped magnet, M (fig. 3), between the poles of which the coil, C, is suspended. The discharges are led into and out of the coil by the suspensions, one being a straight phosphor-bronze strip and the other a spiral surrounding the straight strip. Both suspensions are attached to an ebonite head near the top of the central tubes, this head serving the purpose of zero adjustment; and the arrange-

* Electrical Review, June 24th, 1892.

† See Electrical Review, November 2nd, 1894.

ment is such that the whole of the suspended parts can be readily withdrawn.

The arm carrying the suspension head overhangs the scale, so as to permit of the pointer making one or more complete revolutions, and in this way an instrument having a very long range is obtained. For example, the body of the instrument shown in fig. 2 has a diameter of 4 inches, and the length of the scale, reckoning only one revolution of the pointer, is about 11 inches. As it is quite possible to use 1½ or 2 revolutions without straining the suspensions unduly, we have here an instrument with a scale as long as that of an ordinary

Fig. 2.

reflecting galvanometer (18 inches) in a very compact form. To increase the range of the instrument still further, and to make the instrument suitable for measuring the stray magnetic field in close proximity to dynamo pole-pieces, &c., a switch, S (fig. 3), is arranged to put a resistance coil, R, in series with the suspended coil, thus multiplying its range by 10. The same switch, when moved to the position marked OFF, breaks the circuit of the instrument and lifts a spring, L, which clamps the coil. A short-circuit key, K, on the front of the galvanometer is used to bring the pointer to rest, for when this is pressed the motion of the coil becomes aperiodic.

The scale of the instrument is divided into 200 parts, and as a field tester the sensibility is such that with an appropriate test coil the scale reads off directly the strength of field in C.G.S. units.

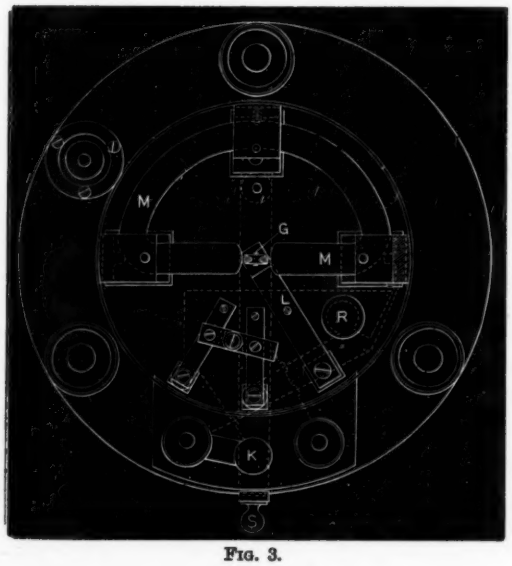


Fig. 3.

For some purposes it is convenient to have the scale graduated in microcoulombs, in which case, besides reading the quantity directly, the swing of the instrument multiplied by the total resistance of the galvanometer circuit measures the total change of induction through that circuit. Such a scale is useful in testing iron for permeability, &c., for by suitably arranging the resistance of the circuit the scale reading can be made to read off $\mathfrak{B}$, the induction density, directly.

Theory of Portable Field Tester.

Let H = strength of magnetic field in C.G.S. units;
n = number of turns in coil;
r = mean radius in centimetres of coils projected on medial plane;
l = mean length of each coil, supposed rectangular;
I = moment of inertia of moving parts;
ω = angular velocity imparted to coil by discharge;
α = torque exerted by suspension when twisted through unit angle;
N = total change of flux through circuit;
R = resistance of the circuit;

Then, assuming that the plane of the coil is parallel to the field of magnet when the discharge passes, we have—

Moment exerted by the coil at any instant

$$= 2\,r\,l\,n\,\mathrm{H}\,\frac{d\,\mathrm{N}}{d\,t}\,\frac{1}{\mathrm{R}} \qquad (1)$$

$$= y\,\frac{d\,\mathrm{N}}{d\,t}\ (\text{say}) \qquad (2)$$

therefore angular impulse $= \int y\,\frac{d\,\mathrm{N}}{d\,t}\,d\,t \qquad (3)$

$$= y\,\mathrm{N} \qquad (4)$$

This must be equal to the angular momentum imparted to the coil, hence

$$\mathrm{I}\,\omega = y\,\mathrm{N} \qquad (5)$$

Now, the energy stored in the coil at the completion of the discharge is

$\frac{\mathrm{I}\,\omega^2}{2}$, and is therefore $= \frac{\mathrm{I}}{2}\left(\frac{y\,\mathrm{N}}{\mathrm{I}}\right)^2$ from (5)

$$= \frac{y^2\,\mathrm{N}^2}{2\,\mathrm{I}} \qquad (6)$$

Now, all this energy is expended in twisting the suspensions through an angle, ϕ, where ϕ is the swing of the pointer. But the work done in the process is

$$\int_0^{\phi} \alpha\,\theta\,d\,\theta,$$

$$= \frac{\alpha\,\phi^2}{2} \qquad (7)$$

Equating (6) and (7) we have

$$\frac{\alpha\,\phi^2}{2} = \frac{y^2\,\mathrm{N}^2}{2\,\mathrm{I}},$$

from which $\phi = \pm \frac{y}{\sqrt{\alpha\,\mathrm{I}}} \cdot \mathrm{N};$

i.e., ϕ is proportional to N.

Appended we give a table showing the relative swings produced by discharging a given quantity of electricity through a given length of wire wound into coils of various shapes. From this it will be seen that the long narrow coil has considerable advantage over common shapes as regards sensibility. At the same time, it permits of much greater range than the forms which necessitate the use of a central core in order to obtain the requisite strength of field to give good shielding from external disturbing fields. The use of a narrow coil also enable swings to be taken in either direction without reducing the range, whereas instruments with cores necessarily have their maximum range of 180° reduced to something less than 90° if arranged to read either right or left of zero.

Table Showing Calculated Swings Produced by Discharging a Constant Quantity of Electricity through a Single Turn of Wire Bent to Four Coils of Various Shapes.

Assuming:—1st, constant magnetic field.
2nd, „ control.
3rd, „ length of wire in coil.
4th, „ diameter of wire in coil.
5th, no added mass.

Shape.	Proportions.	Swing.	Relative moment of inertia.
Rectangular ...	length = breadth × ∞	100	0
„ ...	$l = 10\,b$	94	2·32
„ ...	$l = 2\,b$	75·6	23·1
Square	$l = b$	61	50
Circular ...	...	71	60·7
Rectangular ...	$2\,l = b$	45	68·1
„ ...	$10\,l = b$	14·5	97·6
„ ...	$\infty\,l = b$	0	100

The exploring coil used with this instrument is shown in fig. 4. The coil, C, is fixed to a spindle, A, which is able to rotate through 180 degrees in the handle, B. The spindle, A, is connected to the handle, B, through a helical spring, and by turning the coil relatively to the handle the spring is wound up and retained in this position by a

Fig. 4.

click and trigger, T. This trigger is actuated by the pressure on the key, K, which after closing the galvanometer circuit depresses the lower spring, D, and releases the coil. The area and number of turns in the coil, C, are so made that the deflections in the galvanometer give induction in C.G.S. units per square centimetre.

ON SOME NEW METHODS FOR THE DELINEATION OF ALTERNATE CURRENT WAVE FORMS.

By James Mark Barr, W. Beckit-Burnie, and C. Rodgers, B.Sc.

(*Read before Section A, Ipswich, Wednesday, September 18th.*)

With the progress of alternate current research, it becomes more and more necessary to have a reliable, rapid and accurate means of determining the wave forms of currents and potential differences.

The method now generally in use, namely, the determining of a number of points on the curve and subsequent drawing of a line through these points, though accurate, is tedious, and requires a skilled experimenter. What we need is an apparatus which will automatically record the shape of the wave.

Some years ago Dr. Frölich attempted to use an optical arrangement for showing the shape of the wave. This apparatus consisted of a telephone receiver, the coil of which carried the alternating current, and to the diaphragm of which a mirror was fixed. The diaphragm vibrated with the variations of the current, and a beam of light reflected from the mirror, at any moment indicated by its deflection, the intensity of the current in the coil of the receiver.

This beam of light fell upon a revolving mirror, which imparted to it an independent motion at right angles to that due to the vibrations of the telephone diaphragm. By this means there was traced upon a screen a luminous wave form. Had this arrangement worked satisfactorily, the wave form could have been photographed, and a permanent record instantaneously obtained; but it was rendered totally useless for ordinary frequencies by errors due to the inertia of the moving parts.

This morning we propose to describe an apparatus which we believe overcomes these difficulties, and automatically records with great rapidity the wave form. We employ a combination of two motions at right angles of a spot of light relatively to a screen. An ordinary contact disc is used, *but the contact brush is moved slowly and continuously through its successive angular positions.* Contact is thus made each time at a slightly different position of the armature. Thus the potential difference at each contact differs slightly from that at the preceding contact. This potential difference is used to charge a condenser, across the terminals of which is connected either a reflecting electrometer or a high resistance galvanometer.

The deflection of the instrument so used follows the value of the potential difference of the wave form to be determined, and accurately follows it, for the mean rate of variation of the P.D. between the terminals of the condenser is exceedingly small in comparison with the rate of change of the electromotive force to be investigated. This deflection gives us one of the component motions. The other motion of the light spot is made to be proportional to the angular movement of the contact brush.

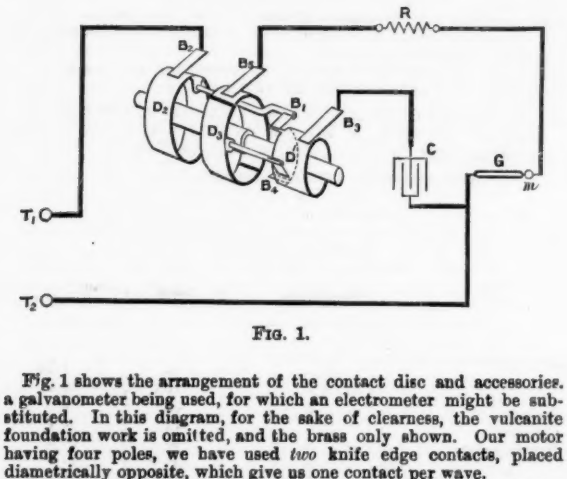


Fig. 1.

Fig. 1 shows the arrangement of the contact disc and accessories. a galvanometer being used, for which an electrometer might be substituted. In this diagram, for the sake of clearness, the vulcanite foundation work is omitted, and the brass only shown. Our motor having four poles, we have used *two* knife edge contacts, placed diametrically opposite, which give us one contact per wave.

D_1 is the contact disc which is rigidly fixed to the shaft of the dynamo or motor, and to it are attached the knife edges just mentioned.

The rings, D_2 and D_3, and the rods and brushes, B_1 and B_4, are mounted on one piece of vulcanite, loose upon the shaft, and are revolved slowly.

The brush, B_1, is joined to the ring, D_2, with which the brush, B_2, is in permanent connection, so that when the brush, B_1, makes contact with the knife edges, the condenser, C, is charged to the potential difference between the terminals, T_1, T_2.

The condenser is throughout the whole revolution of the disc, D_1, discharging through the galvanometer, G, by way of B_3, B_4, B_5, and the resistance, R.

As the brushes, B_1 and B_4, are moved slowly round a succession of charges passes through the galvanometer, the value of each of which is proportional to the instantaneous E.M.F., and the required movement of the galvanometer is obtained. The relative movement of the spot of light at right angles to that due to the galvanometer may be produced in a variety of ways—by a moving screen, by a revolving mirror, or as in the apparatus which we have constructed, by an oscillating mirror. This mirror is shown in fig. 2, which is a plan of the general arrangement, and is marked M. Mechanically connected with the disc, D_2 D_3 (fig. 1), and moving with the same angular velocity, is a cam marked K, which is shown in fig. 2. The mirror, M, is pivoted about a horizontal axis, and is oscillated by the arm, *a*, which bears on the cam. The arm is kept pressed against the working edge of the cam by the spring, S. If the edge of the cam is properly shaped, the horizontal motion of the spot of light in synchronism with the angular motion of the brush is obtained.

We have now two motions at right angles, and by combining them during the oscillation of the mirror, M, in one direction, we cause the spot to trace out a wave form on the screen, P. The spot of light, however, during the return oscillation, would trace the wave reversed, and interfere with the true wave image.

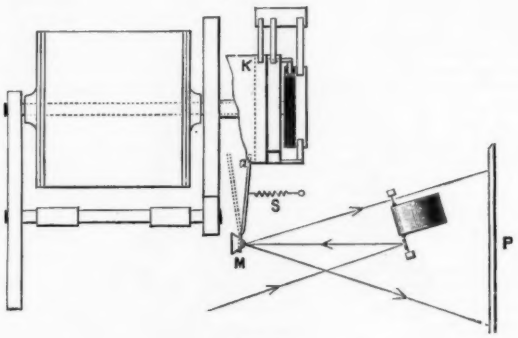


Fig. 2.

In order to prevent this the ring, D_3 (fig. 1), is discontinuous, so that the brush, B_5, during the return oscillation, and the galvanometer circuit being incomplete, the spot *draws the zero line.*

By placing a piece of sensitised paper or a sensitive plate on the screen, a permanent record of the course of the spot is obtained. The angular velocity of the moving brushes may be made so small, that a well damped instrument, even of long period, may be used. For use with an ordinary electrometer, the plane mirror may be made to oscillate about a horizontal axis and a curve drawn, the zero line of which is vertical.

The cam may be dispensed with and the screen itself moved, either horizontally or vertically, with gearing. Or a cylinder covered with sensitive paper may be attached to the moving brushes, and the deflection of this made to move the spot axially on the cylinder. But there are certain disadvantages attached to this method of experimenting, which made us decide to construct the apparatus with the cam. There have been brought out lately several methods for building up current and electromotive force wave shapes. In using this apparatus during the process of building up wave forms, the required shape may be drawn upon the screen and the course of the spot of light observed, it being noted wherein it differs from that curve, and steps being taken to insure a close coincidence.

With the forms of apparatus in which the cam is not used, this process is more difficult.

A short time ago Dr. Fleming published a new and ingenious method of plotting wave forms with polar co-ordinates, and of directly obtaining therefrom the root mean square value. Our apparatus may be easily modified so as to obtain a record of one of these polar waves. For this purpose, the slow moving disc must be mounted on the extreme end of the shaft, and a sensitised screen must be fitted thereon. The instrument must be so placed that the zero position of the spot of light falls on the centre of the disc and the deflection along one of the radia. The curve traced will then be of the required form.

By a system of mirrors, it would be possible to obtain the same result with the screen fixed, but this appears to offer no special advantages.

The galvanometer which we have up to the present used with our apparatus is of the Ayrton-Mather type with a horizontal coil, but no silver tube for damping. The coil is wound with 260 turns of wire 1·4 mils in diameter, with a resistance of 400 ohms. The period is small, being about $\frac{1}{10}$th second. The damping is effected by a light glass arm dipping into an oil vessel, the height of which can be adjusted.

An electrometer would have been preferable, but it is difficult to obtain an electrometer of sufficiently small period. For tracing the wave very slowly an electrometer may be used, but one of the advantages of our method over the methods in ordinary use is the rapidity with which the wave may be traced. In many experiments there is a variation of speed with time, against the effects of which it is necessary to guard, but in tracing a wave in a few seconds, no appreciable variation of speed can take place.

We have here a photograph of a P.D. wave form taken by means of this apparatus. As the experiments were performed after the closing of the college, the only current available was that from a small four-pole motor transformer. The consequence is that there is a series of steps in the wave due to the commutator segments, which were comparatively few in number. This, of course, gives a wave form not so nice in appearance as an ordinary sine wave, but it is so much the more a severe test of our apparatus.

In determining the curve by the ordinary method, the irregularities would not have been so clearly seen unless an exceedingly large number of points had been taken. The spot of light was rather unsatisfactory, there being a small auxiliary spot by the side of the main spot. This small spot traced a curve itself which can be distinctly seen on the photograph, and which detracts somewhat from

the clearness. We should much have liked to show a smooth wave form taken with this apparatus, and a satisfactory spot of light, but the constructive work was finished only last Saturday, and we have not had time to perform many experiments with it.

If the spot of light were made to trace out the wave form sufficiently rapidly, the curve would appear as a continuous luminous line. This can be effected with the apparatus as it now stands with *high* frequencies. With low frequencies, however, that is impossible. For instance, with a frequency of 80 alternate per second, we obtain 80 contacts per wave. But since for the line to appear continuous the slow moving disc must make five revolutions at least per second, the number of contacts cannot exceed eight per complete period, or four per half wave—an obviously insufficient number.

We have here (fig. 3) a diagram illustrating a method by which this difficulty is overcome. As before, the apparatus consists of two discs—one moving at the speed of the motor, and the other a slow moving one. The slow moving disc carries two collecting rings, two brushes, and an internal four-part commutator. Each collecting ring

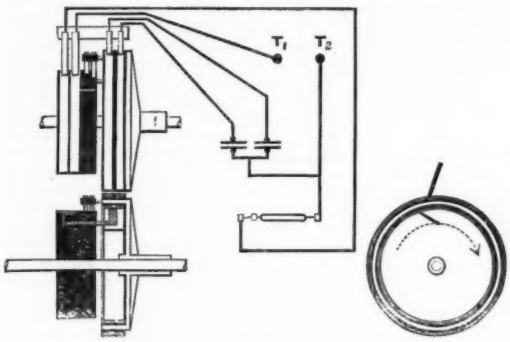


Fig. 3.

is connected to a pair of opposite commutator segments, and the slow disc carries two brushes, which bear on the fast disc and are connected one to each collecting ring. The fast disc also carries two collecting rings—one connected to the knife edge and the other to the fast revolving brush which bears on the four-part commutator of the slow moving disc. The two brushes carried by the slow moving disc are slightly in advance the one of the other, and the slow moving disc is rotated so as to have a definite speed relation to the fast disc. The two condensers are charged in rapid succession as the knife edges pass the brushes, and during the remainder of the half revolution are discharged in succession through the four-part commutator, the fast revolving brush and the galvanometer. The effect is to get *twice* as many discharges through the galvanometer per wave as is obtained with the apparatus shown in fig. 1. Three or more condensers can be used, the total number of contacts per wave obtained being proportional to the number of condensers used. For all ordinary purposes, however, the apparatus with one condenser will be found most convenient.

In conclusion, we must acknowledge our indebtedness to Prof. Ayrton and Mr. Mather for their kind advice, and to Mr. W. Duddell, one of our fellow students, for his help during the construction of the apparatus.

EXPERIMENTS FOR IMPROVING THE CONSTRUCTION OF PRACTICAL STANDARDS FOR ELECTRICAL MEASUREMENTS.

(*Submitted to Section A, September 18th*, 1895.)

Report of the Committee, consisting of Prof. Carey Foster (Chairman), Lord Kelvin, Profs. Ayrton, J. Perry, W. G. Adams and Lord Rayleigh, Drs. O. J. Lodge, John Hopkinson and A. Muirhead, Messrs. W. H. Preece and Herbert Taylor, Prof. J. D. Everett, Prof. A. Schuster, Dr. J. A. Fleming, Profs. G. F. FitzGerald, G. Chrystal and J. J. Thomson, Messrs. R. T. Glazebrook (Secretary) and W. N. Shaw, Rev. T. C. Fitzpatrick, Dr. J. T. Bottomley, Prof. J. Viriamu Jones, Dr. G. Johnstone Stoney, Prof. S. P. Thompson, Mr. G. Forbes, and Mr. Rennie.

(*Continued from page* 349.)

11. *Another* mode of measuring the total induction through an area is to surround that area with a movable electric circuit of n turns of wire conveying a known current, and to measure the potential (or mechanical) energy of the circuit under those conditions. The induction is equal to the potential energy of the circuit divided by n times the current circulating in each turn of wire.

Or, if the induction through a simple circuit carrying 1 ampère is 1 weber, the potential energy of the circuit is 1 joule.

Derived Quantities.

12. Induction density, or B, may be expressed as so many webers per unit area; say, per square centimetre or per square inch, or whatever is preferred for practical purposes.

For instance, the earth's horizontal induction density at some place is ·18 C.G.S. unit = ·18 × 10^8 weber per square centimetre = 18 microwebers per square metre.

13. The inductivity (μ), or absolute permeability of a medium at any point under specified circumstances, is the ratio of B to H at that point, and under those circumstances. In many substances this ratio is far from constant. [It may be expressed in terms of henries or other units of permeance per unit length (see below), instead of in C.G.S. units, if convenient. For example, the inductivity of air is $\frac{1}{100}$th of a microhenry per centimetre, or 1 millihenry per kilometre.] More explicitly it is measured by the webers per unit area divided by the gauss fall per unit length; in other words, by the ratio of the weber density to the gauss gradient.

14. The relative inductivity of a substance as compared with that of empty space (μ/μ_0) may be called simply its "permeability" as at present, and is a mere number.

(Its electrical analogue is specific inductive capacity (K/K_0), as contrasted with absolute electric inductivity (K), which latter could be defined in practical units as the ratio of the coulombs displaced per unit area to the volt gradient.)

Third Quantity to be Named.

The third quantity for whose unit a name is required is some form of ratio between the two fundamental quantities whose units are here named after Weber and Gauss respectively. It has been practically decided in America that this unit shall be named after Prof. Henry, of Washington, but the precise definition has not yet been agreed upon.

There are two quantities of the same physical dimensions to which the name is applicable, viz., the coefficient of self or mutual induction of a coil or coils of wire, and the permeance or inverse reluctance of a magnetic circuit.

The most logical order is to define permeance first, as the ratio of the webers of induction to the exciting gaussage, and then to say that the inductance of a coil of n turns of wire is n^2 or $4\pi n^2$ or $\cdot 4\pi n^2$ times the permeance of the magnetic circuit which it embraces, according to the units of gaussage and current which have been decided on.

If the units of gaussage and current are both the C.G.S. units, then $4\pi n^2$ is the numerical factor connecting inductance with permeance.

If the C.G.S. unit of gaussage is adopted along with the ampère current, then $\cdot 4\pi n^2$ is the factor.

But if the circulation of H due to 1 *ampère turn* is adopted as the practical unit of gaussage, then n^2 is the factor; and the permeance of a cylinder, instead of being simply $\frac{\mu A}{l}$, is $\frac{4\pi\mu A}{10 l}$.

The apparent simplicity of this last system has much to recommend it for commercial use, though it will complicate the specification not only of permeance, but also of magnetic fields and potentials; but *some* inconvenience due to the unfortunate definition of the unit pole, and the only less unfortunate definition of the practical unit of current, cannot be avoided; and our aim must be to place the inconvenience where least likely to be felt in every-day work.

First System.

We will begin with the more logical system, and with general statements which apply to both.

15. In a complete magnetic circuit, the ratio of the total induction to the corresponding gaussage under specified conditions is called the "permeance" of that circuit under those conditions. It is not in general constant.

Or, the permeance of any solenoidal portion of a magnetic circuit, if free from intrinsic magneto-motive force or magnetic boundary layers, is the webers through it divided by the gausses between its ends.

16. The practical unit of permeance is that of a circuit in which a weber is excited by a gauss. Its reciprocal is the unit of reluctance. The practical unit so defined is 10^8 C.G.S. units.

Examples.—The permeance of a cubic metre of air to parallel induction from one face to the opposite is 1 microweber per gauss.

Under circumstances such that the permeability of iron is 400 times that of air, the permeance of an iron ring of 1 decimetre cross section and 1 metre in mean diameter is $\frac{400\pi r^2}{2\pi R} = 20r = 100$ C.G.S. = again 1 microweber per gauss.

It is, perhaps, a question whether this amount of permeance could be called "a microhenry" without confusion.

Explanation.- The inductance (or self-induction coefficient) of an electric circuit consisting of n turns of wire, so far as it is constant, is defined to be equal to n times the induction produced through it by a current of 1 ampère in each turn. But the gaussage due to n ampère turns is $\frac{4\pi n}{10}$ or $\cdot 4\pi n$; hence the inductance of a wire coil is $\cdot 4\pi n^2$ times the webers caused by each gauss in the magnetic circuit surrounded by it; *i.e.*, is $\cdot 4\pi n^2$ times the permeance of that circuit considered as constant.

17. A coil of wire threading n times a complete magnetic circuit of unit permeance under any given circumstances is said to have $\cdot 4\pi n^2$ units of inductance under those circumstances; and in general the inductance of a coil of n turns is $\cdot 4\pi n^2$ times the permeance (as above defined) of the magnetic solenoid enclosed by it. (The permeance may here be considered variable.)

[With the ampère turn as unit gaussage the $\cdot 4\pi$ is prefixed similarly to both inductance and permeance, so that only the factor n^2 is needed to convert one into the other. See below.]

18. The C.G.S. unit of inductance is equal to n times the induction excited through a coil per C.G.S unit of current in every turn of wire; whereas the practical unit of inductance is n times the webers excited per ampère; hence the practical unit of inductance is 10^9 times the C.G.S. unit.

The practical unit is called a "henry." (It has also been called secohm and quadrant.)

Example.—If the above iron ring were wound closely with 1,000 turns of wire, the coil would have a coefficient of self-induction equal to $\frac{4\pi}{10}$ or 1¼ henries whenever the permeability of the iron was 400.

A coil of 20,000 turns of wire, wound closely on the same core, would have an inductance of 1¼ henries if it contained air or other non-magnetic substance.

ALTERNATIVE MODE OF DEFINITION OF INDUCTANCE ON FIRST SYSTEM.

In view of one of the above practical methods of measuring induction experimentally, the inductance of coils of wire, both self and mutual, may be defined more directly thus:—

19. When of two simple circuits one conveys a current, the other in general has induction caused through it; and the ratio of the induction through either to the inducing current in the other is called the mutual inductance of the circuits.

20. Of two coils, with n and n' turns respectively, the total mutual inductance is to be reckoned for every turn of wire on each coil, and is therefore $n\,n'$ times the inductance of the mean turn of one coil on the mean turn of the other.

21. The mutual inductance of two coils is $4\pi n n'$ times the permeance of the largest magnetic solenoid which threads both. For if every turn of one conveys a current, C, while every turn of the other surrounds an induction, N', in consequence, the permeance of the magnetic solenoid threading the second coil is $P = N'/4\pi n C$; but the total effective mutual induction, M C, through all the turns is $n' N$; hence $M = 4\pi n n' P$.

22. When two coils each conveying 1 ampère are constantly connected by 1 henry of mutual inductance, the kinetic energy of the field due to their mutual action is 1 joule.

23. If the *self*-induction coefficient of a coil is being considered, its total inductance may be taken as n^2 times the inductance of the mean turn; that is n times the total induction through it divided by the inducing current. Or the weber turns per ampère give the self-inductance in henries.

24. The practical unit of inductance, whether self or mutual, is called a henry; and a coil of n turns has a henry of inductance, on itself or on another of n' turns, when an ampère in one maintains $1/n'$ weber of induction (through itself or) through the other.

25. When the induction through a coil varies for any reason at the rate of 1 weber per second, the E.M.F. generated in each turn is 1 volt.

26. When the inductance of a coil is 1 henry, on itself or on another, a small variation of current in it at the rate of 1 ampère per second induces an E.M.F. of 1 volt in itself or in the other.

27. When the inductance of a coil conveying 1 ampère varies at the rate of a henry per second, the induced E.M.F. is 1 volt.

28. When the self-inductance of a coil is constantly, or on the average, 1 henry, while an ampère current is generated in it, the kinetic energy of the field due to that ampère is half a joule.

SECOND SYSTEM.

29. If instead of taking a gauss as equal to a C.G.S. unit of magnetic potential, we take the circulation of H caused by 1 ampère turn as the practical unit of magneto-motive force, we shall have 1 ampère turn $= \frac{10}{4\pi}$ C.G.S. units of gaussage.

30. The practical unit of permeance will then be that in which a weber of total induction is excited by each ampère turn; in other words, it will be $4\pi \times 10^7$ C.G.S. units of permeance.

31. And the practical unit of inductance will be that of a coil in which an ampère in every turn excites $\frac{1}{n}$th of a weber through every turn; that is to say, the inductance of a coil will be n^2 times the permeance of the magnetic circuit surrounded by it.

32. The difference between inductance and permeance is only one of reckoning. Permeance is webers per ampère turn. Inductance is weber turns per ampère.

SUMMARY OF THE ADVANTAGES OF THIS SORT OF MODE OF DEFINING UNIT INDUCTANCE.

The special feature of this mode of defining the "henry" is that it makes inductance depend on the simple ratio N/C, or weber turns per ampère, instead of on something more complicated.

It might possibly be defined as the ratio $d\,N/d\,C$, that is, as proportional to the tangent of the slope of the B : H curve; and such a definition would emphasise its variability; but certain practical advantages would be lacking, because it would be detached from any connection with the *permeance* of the circuit. The N/C ratio on the other hand instantly connects itself with permeance, and represents the slope of the secant drawn from the origin to any point of the B : H curve. It exhibits the variability sufficiently; making the inductance reach a maximum at the shoulder of the curve, and then slowly decrease as saturation sets in.

It is sometimes said—but the mode of expression is, to say the least, very inconvenient—that there are three different principles on which to define L, all leading to a different result, viz., numbering them inversely, but giving them in their usual order:—

(3) Energy . . . $W = \frac{1}{2} L C^2$
(2) E.M.F. . . . $E = L\,d\,C/d\,t$
(1) Total induction $N = L C$.

But the real facts to be expressed are not here exhibited. The real facts are

(1) $N = L C$
(2) $E = d\,v/d$
(3) $d\,W = C\,d\,N$.

The essential thing to name is therefore N; and if 10^8 C.G.S. lines or unit tubes be called a "weber," or a "weber turn," then a volt is a weber or a weber turn per second, and a joule is a weber-ampère turn. Nothing can be handier than that; and a henry can be defined as a weber-turn per ampère.

Instead of saying, as above, that there are three ways of defining L, the simplest thing is to say that two of the three equations, as first given above, are incorrect, except for the special, and, in practice, comparatively rare case when L is constant. Written out correctly, they stand as follows:—

$$(1)\quad N = L C$$

$$(2)\quad E = L\frac{d\,C}{d\,t} + C\frac{d\,L}{d\,t}$$

$$(3)\quad W = \tfrac{1}{2} L C^2 + \tfrac{1}{2}\int_0^C C^2\,d\,L.$$

It is then obvious that (2) and (3) are too complicated to base a definition upon, and that the first alone gives a feasible system.

The fact that L is decidedly not in general constant, deprives the henry of any such importance as the ohm possesses; moreover, it refers explicitly to rather a special thing, viz., a coil of wire, and that under specified conditions, if it contain iron; hence it would be rather absurd to name this alone of all magnetic units. In the above communication, in addition to a certain mode of defining the henry, it is urged that unit total induction be named, too; for this is the quantity which is of real engineering importance—this is the quantity to attain which field magnets are built, and in the midst of which armatures are spun.

It is also urged that it would be convenient if unit magnetic potential could likewise be named, since electrical engineers have shown that they have need of some such unit for the exciting cause of induction, by their practical employment of the phrase "ampère-turns." The introduction of a gauss unit, in some form not too obviously limited to the case of a wire-wound coil, would assist teaching and would clarify magnetic ideas.

The present writer does not pretend to decide between the two alternative systems of defining "the gauss," as given above, viz., the C.G.S. unit on the one hand, and the ampère turn on the other.

OLIVER J. LODGE.

Liverpool, *December 9th*, 1894.

(To be continued)

THE INCANDESCENCE LAMP.*

BY A. BAINVILLE.

(*Continued from page* 222.)

THE PERFECT LAMP.

WE have studied the successive stages of the manufacture of the incandescence lamp as it is carried out at the present day; we have enumerated the conditions of its working satisfactorily, and also the causes that bring about its normal or accidental destruction; we have thus set forth the actual state of affairs with regard to this question, but it is very evident that this state of affairs is far from being an ideal one. What course must we pursue to attain better results, what are the points that most require improvement, what points can most easily be improved, and, lastly, what points it is most to our interest to improve? To answer these questions is really to describe the perfect lamp as we conceive it, and at the same time to indicate in what direction researches should be made in order to approximate as nearly as possible to this perfection.

We will first examine what are the imperfections of the incandescence lamp, enumerate them, and discuss their causes.

The imperfections to be found in the incandescence lamp are numerous. Some are inherent in the lamp itself; they depend on the principle on which its construction is based; others, on the contrary, depend on the manner in which this principle is applied. The former, therefore, can only be remedied by finding a means other than incandescence of transforming electrical energy into luminous radiations; whereas the latter would only necessitate certain improvements in the present mode of manufacture. These, which we will examine first, nearly all relate to the filament. We have seen that the filament is a very bad transformer of electrical energy into luminous energy, since the present lamps have only an efficiency of 5 per cent., and by increasing the temperature of their working, which, as we know, increases the proportion of photogenic radiations for a given

* *L'Electricien.*

quantity of energy expended, we can seldom hope to attain in luminous energy more than 10 per cent. of the electrical energy consumed.

We may now consider that it is in the increase of the efficiency of this transformation that the greatest progress is to be realised.

The other imperfections of importance in the filament of the present day are chiefly due to the wear of this filament itself; these are—variation in the electrical resistance which brings about variation in the luminous power with the duration, and also variation in the nature of the surface of the filament, which also has a considerable influence on the value of the luminous power. We will not dwell upon the diminution of the co-efficient of elasticity of the filament between ordinary temperature and incandescence, which, as we know, causes some inconvenience in practice and sometimes constitutes a cause of destruction.

The more or less perfect transparency of the bulb, and more especially the modifications that it undergoes during the existence of the lamp are also amongst the points capable of improvement in this industry. This transparency, moreover, is greatly dependent on the quality of the filament, since the layer of carbon that produces the diminution of the transparency of the bulb arises solely from this filament.

We can now define the perfect incandescence lamp as that in which the physical properties of the filament would remain constant during its whole duration; this duration, moreover, being sufficiently long, as long, for instance, as that of the lamps in present use; this filament to be enclosed in a bulb of perfect transparency maintained during the whole duration of the lamp; the vacuum produced in this bulb to approximate as nearly as possible to a perfect vacuum, and to retain this character all the time the lamp is working. Such a lamp should, moreover, terminate its existence automatically as soon as one of the above conditions ceases to be realised.

To what extent can such conditions be arrived at? Can we hope to approach the perfect lamp, or should we at once seek some other mode of transforming electrical energy into luminous energy than this rough method, which consists in heating a conductor until it is rendered incandescent? In the first place, is it possible to increase the luminous efficiency of incandescence lamps? Probably it is, but on condition that we give up pure carbon. We cannot, in fact, hope to increase this efficiency without at the same time increasing the emissivity of the surface of the filament, or without increasing the dimensions of the surface emitting the unit of light. With carbon, we can only increase the efficiency by raising the temperature; now this temperature cannot be raised without endangering the duration of the filament; we have already seen that all the influences tending to the destruction of the lamp become exaggerated as the temperature is raised, and, finally, we can never exceed a certain limit of temperature, viz., the point of fusion of carbon. On the other hand, although carbon has all these drawbacks, it has the advantage of possessing a very high emissivity, far superior to that of the other substances that we might think suited to our purpose.

Certain metallic oxides, the earthy oxides in particular, such as those used in the manufacture of the Auer hood, possess the property of transforming the calorific radiations into special luminous radiations; they might perhaps be used in the production of the filament, but their enormous resistance to the passage of the current would be an obstacle to their employment. In all cases, such filaments should be of considerable section and very short length, the fitting of them into the lamp would be a very delicate operation, and would probably necessitate special mechanism; thus one of the most important advantages of incandescence lamps would be lost, viz., their simplicity of construction and working. It is even probable that these oxide filaments could not be realised for low voltages, and could hardly be utilised except in cases of thousands of volts at the terminals, which would constitute a fresh difficulty, and would render the use of such lamps dangerous and consequently impracticable. There are, in fact, several reasons why this should be the case. In the first place their very low electrical conductivity, the consequences of which we have just indicated, and, secondly, the very low emissivity that these substances seem to possess. This latter characteristic would, like the former, necessitate an excessive amount of surface, but in proportions which do not seem compatible with the conditions required.

The surface of emission of a carbon filament producing 16 candles, for instance, is seldom more than 80 square millimetres for the temperature corresponding to a consumption of four watts per candle, and 60 square millimetres for the temperature of the filament of the three-watt lamp (these figures vary a little according to the nature of the carbon composing the filament, in filaments that are not flashed and according to that of the carbon deposited by carburetting on the surface of the flashed filaments); this surface is, at least, fifty times less than that of the Auer hood which would give out the same quantity of light. On the other hand, one of the inconveniences of the carbon filament is its too great conductivity, a property which, as a rule, is exaggerated in the manufacture of the filament, as the qualities of homogeneity, density, and elasticity, which should be as high as possible in a good carbon filament, increase as the conductivity becomes greater. It is this low specific resistance, in fact, that renders so difficult the construction of high voltage lamps, the filaments of which become so slender that it is not easy to make them, and so long that, as they are no longer sufficiently rigid to support themselves in the bulb, they have to be held in position by little platinum hooks. It is evident that it would be advantageous to lessen this conductivity without impairing the qualities that it implies; the result would be an increase of section and at the same time a diminution of length, all other conditions remaining equal. A simple modification in the form of the section enables this *desideratum* to be realised to a certain extent. The filament with a circular section, which is generally employed, as its manufacture is simple and allows of great uniformity being obtained, is the one in which the radiating surface is least per unit of length, and consequently the one in which the length required to obtain a certain luminous power at a certain difference of potential is greatest, all other conditions being equal. The square section would enable the length of the filament to be reduced and this reduction would become still greater with the rectangular section in proportion as it was further and further removed from the square. It seems therefore that it would be to our advantage to use flat filaments, especially for high voltage lamps.

However, these variations in length resulting from the modifications of the form of the section are not sufficiently great to be of any real interest or to compensate for the inconveniences resulting from these modifications. The flat filaments which, by the way, several incandescence lamp makers have adopted, besides being somewhat more difficult to make, are unsymmetrical; consequently, their elasticity is different in different planes; the same may be said of their horizontal luminous intensity.

The only really efficacious means of reducing the conductivity of the filament without at the same time going too far in the opposite direction, consists in slightly altering the nature of the substance of which it is constituted, or in introducing into this substance a body of very great specific resistance. This last solution of the problem has been proposed and tried on various occasions without much success. To attain this object, several modes of procedure occur to us. We can, as we said, introduce into the carbon that constitutes the filament at the present day a metallic salt mixed in with the carbon intimately so as to form a perfectly homogeneous whole; we might choose one of those infusible oxides that can only be decomposed with difficulty, such as those belonging to the series of earthy metals, which we discussed above, and which are also endowed with certain photogenic properties; we might also content ourselves with enveloping the filament in a sheath formed of these same oxides; lastly, we might make with the carbon a chemical combination possessing very great stability and endowed with properties similar to those of carbon, at the same time having less conductivity.

The first method condemns itself at once, seeing that it appears probable, if not certain, that these oxides thus introduced into the carbon will be rapidly reduced under the simultaneous influence of the carbon, the electrical current, and the high temperature to which they are brought. In this case, what will happen? At the very beginning the reduction will have the effect of increasing the conductivity of the filament, whilst the product of the reduction will not be volatilised: whence there will be a considerable increase

in the brilliancy of the lamp, *i.e.*, an elevation of the temperature of the filament, since the difference of potential remains constant; but this period of brilliancy will be of very short duration, as it will increase the volatilisation; then, finally, the resistance of the filament being increased, the luminous power will diminish, and all the more rapidly from the fact that the products of the volatilisation which are deposited on the bulb diminish its transparence. Such a lamp, therefore, does not seem likely to be preferred to those now in use, far from it. The second method does not seem to be much more practical. In fact, this outer layer, which does not enter into the composition of the filament, will not have exactly the same co-efficient of dilatation as the carbon that constitutes the core; and most probably in a very short time rents will be produced in this outer envelope, the elasticity of which must necessarily be very slight; consequently, it will quickly fall to pieces, as is seen, moreover, in ordinary lamps when the deposit of carbon produced by the carburetting is formed under bad conditions. Besides, as the emissive power of the layer of oxide seems very low in proportion to that of the carbon, we cannot easily see how lamps, the filaments of which are thus constituted, can furnish the luminous power generally required from apparatus of this kind. This solution could not therefore be applied with advantage, it seems; for even if we leave aside this question of emissive power, we have to do with a lamp the lighting power of which may suddenly be reduced, seeing that after the fall of the outer envelope, its radiating surface would be suddenly lessened while its electrical resistance would be considerably increased.

The last method might perhaps give really practical results, that is, on condition that we find a combination sufficiently stable to resist the reducing influences that are present, sufficiently infusible to support a temperature at least as high as that of the present low wattage lamps, and sufficiently easy of construction to be produced practically. Certain carburets would perhaps satisfy these conditions; but the few attempts that have been made in this direction, have not as yet, to our knowledge, given any really satisfactory results.

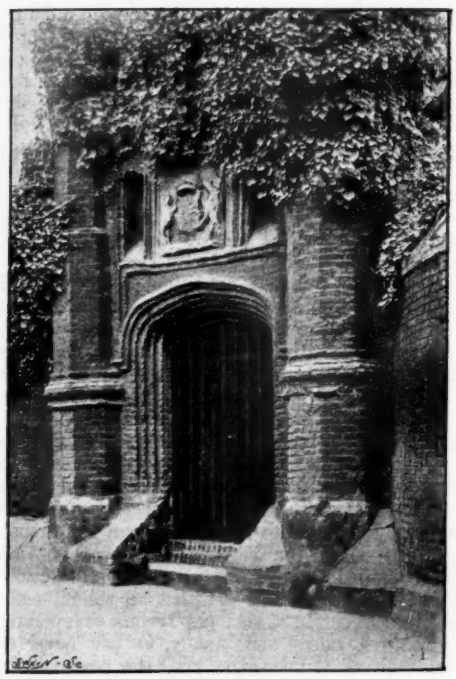
In short, experiments bearing upon the improvements to be made in incandescence lamps should, in our opinion, be directed to the production of filaments composed of one substance only, either simple or composite, and not of a mixture, however intimate; this substance should possess the following properties: infusibility at least equal to that of carbon, higher specific resistance, and great emissive power; it should, moreover, behave under any conditions like a simple body, and be obtainable in the form of wires of very small diameter possessing great elasticity.

Besides this solution, it is perhaps possible to obtain the transformation of electrical energy into luminous radiations more satisfactorily than by the incandescence method. The luminous phenomena which accompany discharges *in vacuo*, the illuminations produced by tubes of rarefied air placed in the magnetic field of high frequency currents of the Tesla type, may be the starting point of new and fruitful researches.

Electric Side Lights.—The disastrous collision of a Spanish cruiser with a merchant steamer off Havanna, which occurred last week is said to have been caused by the electric side lights being suddenly, and without warning, extinguished. It appears that a sailor by some means or other became entangled in the electric lighting machinery, and those in charge of it very naturally at once stopped it in order to save the man's life. The result of this was the loss of some 50 men's lives and the cruiser herself. Curiously enough on the same day as this news was published, appeared the result of the inquiry on the loss of the *Prince Oscar* by collision with an unknown ship in the South Atlantic. In this case, also, the two ships were approaching one another when it was found that the *Prince Oscar's* port side light—an oil lamp—was extinguished, and although it was lit and replaced in the screen within three minutes, it is possible that the collision, which took place soon afterwards, may have been due to this cause.

THE BRITISH ASSOCIATION.

The fact that the British Association has this year held its annual meeting at Ipswich will not justify us in perpetrating a historical sketch of that ancient town. Being gifted with a rare imagination, we are confident that we might add much to the history of Ipswich, but having regard to the disabilities under which we labour, we will restrain our wayward fancy. It is not to be denied that the ancient Suffolk town is rich in associations with the past; there is still preserved a ducking stool much used before the reformation of woman, and there are several houses in which Wolsey is said to have been born; this discloses a phase in the ubiquitous character of the Cardinal that seems to have been overlooked. Unfortunately, Ipswich has been much possessed with a spirit of self-effacement, and where it has not successfully removed ancient landmarks, it has done much with the aid of paint. But in spite of the great figure that it makes in history, it is a remarkably clean and well ordered town. The public buildings are striking, and for the most part are of pleasing design; altogether it is one of the most charming towns in which the British Association has met for years.



Wolsey Gate.

It seems to us that no apology is needed for introducing into this article two or three characteristic bits of Ipswich.

The British Association of 1895 can be in no way considered a remarkable one from an electrical point of view. There were certainly some good papers in Section G, on what was somewhat euphemistically termed electrical day, but the complete list was not an extensive one. Section A produced one or two good things. Early in the sittings of this section there was some little excitement manifested at the attempt to establish the character of a gas. We are not sure what sort of a character was made out, for in spite of some energetic remarks the discussion fizzled out in a rather lamentable manner. It was, moreover, not very interesting, and our condition may be likened unto a man who speaking of the discussion said he had had a grand time in Section A, but subsequently admitted that he had slept during the greater part of the debate.

Major-General Webber's paper on light railways was brought before the mechanical section on Thursday, and provoked a fairly good discussion. The debate, however, rather wandered away from the chief point of the paper, which was a consideration of light railways as an aid to commerce. The discussion rather pivotted on the question of gauge and as to whether man or locomotive was deserving of more consideration on the public highways. Mr. Ander-

son, of the Arsenal, speaking on behalf of the survival of the fittest theory, thought that the world could get on very well without the man who could not get out of the way of a locomotive. It is a comfortable sort of doctrine to hold and has the advantage of being rather clever.

There was nothing of interest to electrical men in the sections until the fourth day of the meeting, when a paper was contributed to Section G by the borough analyst on the subject of the Hermite process. This communication derived its chief interest from the fact that the deodorising of sewage by the Hermite process has been in use for some months at Ipswich. It is not a very extensive experiment, however, being chiefly confined to the main sewers. We believe we are correct in saying that the promoters of the Hermite process in this country considered the application of the system to be chiefly valuable when it was applied throughout a sewage system, for example, in the sinks and other domestic appliances as well as in all the arterial sewers. Apparently the town officials at Ipswich are more than satisfied with the results, and there is every indication that the Hermite process will be considerably extended. We have said so much about the system in the Electrical Review at different times that it is quite unnecessary to say anything here except to mention the fact that Ipswich being an inland seaport town there is an abundant supply of sea water obtained for the tanks.

Christchurch.

It was remarkable how few electrical men there were in Ipswich during the earlier part of the meeting. It was of course common knowledge that papers were to be read during the last few days, consequently few men put in an appearance before Monday, and it was surprising how quickly they disappeared after they had unburdened themselves of their communications.

Sparrowe's House.

We ought not to omit to mention that one of the popular lectures was by Prof. Silvanus Thompson on "Magnetism in Rotation." In many respects it was a capital discourse, but for a popular audience—and we do not consider the British Association anything else—there was too much history. The experiments, however, were well done, and, as a performance, it was distinctly better than the Egyptian Hall. Prof. Thompson, however, for once, nearly failed as a lecturer. It may have been for some occult reason, but we never heard the professor to less advantage. Certainly, the awful state of the atmosphere may have accounted for a good deal; it made one limp in less than five minutes, and the surprising thing is that not more people were hurt.

On Monday, electrical men metaphorically girded up their loins, and went forth to Section G to gird one another. There was a fairly good number of electrical men present, but fewer than in previous years.

Mr. Preece, who was on the programme for "Notes on Further Advance on Induction Telegraphy," had nothing to say—one is inclined to ask if that is as far as induction telegraphy has advanced. Mr. Dawson, however, filled the breach on the platform, and delivered himself of some formidable facts on electric traction. This paper was given in full in the last issue of the Review. It was, perhaps, the most notable paper presented, and is worthy of very close attention, for it embodies the views of the two foremost authorities on electric traction in this country, Mr. R. W. Blackwell, and the author of the paper, Mr. Phillip Dawson. The discussion was mostly interesting.

Mr. Blackwell, in opening the discussion, said the tramways in Great Britain, as a whole, needed regeneration; they had no social standing, and it was only by the adoption of mechanical power that it could be improved. The overhead wire had disadvantages, but they were small compared with the advantages. Electric traction, however, had commenced to go in a way that was likely to continue. The first cars had run at Bristol. Cars at Dublin were about to be started, and in a short time Coventry would be opening eight or ten miles of track. On the Continent the progress had been more than remarkable. English tramway builders had large contracts on hand, and it was making progress day by day, as it did in America. The arguments that were used in this country about spoiling the streets were exactly what had been used in America. His own opinion was that the trolley wire was the only system they could look forward to for many years, and if they were not prepared to adopt it, they could give up the possibilities of rapid transit. It could be fairly said that there was no indication at present of any other system of traction being brought before the public which could compare with the overhead wire system.

Mr. Preece said he had just returned from the Continent, and was surprised to find that they had not made the progress in Germany which he expected. Berlin was looked upon as the home of electrical railways, but he found they were just starting their first electric tramway there. The interference to the telegraphs caused by electric railways was a most serious one. As they all knew the Post Office in this country was not an obstructive body, it rather assisted than retarded general progress. They had always relied upon the strong desire of the managers of electric railways to do their best to remove the disturbance. He was once thought to be an objector to the trolley wire, but he was not; what he had objected to was the guards necessary for the telephones in Boston. He had no doubt that those purists who thought that the beauty of their towns was going to be destroyed, would admit, at any rate, that the brackets and posts that supported the trolley wire were infinitely better than a lamppost, whether it were for a gas lamp or arc lamp.

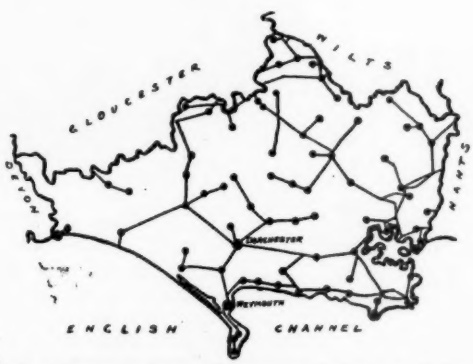
Other speakers followed, but their remarks, while useful in disseminating knowledge, were not very interesting. Mr.

Phillip Dawson, in his reply, showed a great command of figures and statistics relating to what had been done in traction.

Mr. Earle's paper on "Storage Batteries" formed a useful contribution to one's knowledge of the chloride battery. There was a passing knock at engineers' specifications for storage batteries.

We should like to have had space to speak fully on "An Improved Portable Photometer" presented by Mr. A. P. Trotter and Mr. W. H. Preece; it was one of the neatest things for measuring the illumination of street lamps that we have ever seen. But our readers will already have seen the very full account published in our last issue.

We have dealt very fully in another place with the telephone papers of Major-General Webber and Mr. A. R. Bennett. There is only one thing we should like to do here, and that is to show a telegraphic map of Dorset side by side with Mr. Bennett's telephone map of Luxemburg. The



Map of Dorset Showing Telegraph Lines and Offices.

comparison may not have very much bearing on the question at issue, but it is interesting; it would have been still more interesting if one could obtain a telegraph map of Luxemburg.

Of the papers that were presented to Section A on Tuesday, we may have something to say in a future issue.

The illustrations are from photographs by Mr. W. Vick, Ipswich.

CORRESPONDENCE.

Municipal Salaries.

I have a strong objection to trespass on the space of our technical journals, other than that devoted to advertisements, by bringing before their readers any topic which may be interesting to only a comparatively small section of the electrical community.

My excuse for the somewhat narrow subject of this letter must be that although primarily of particular interest, it has a secondary and general bearing on the well-being of the whole community.

Electric light, which a few years ago was classed amongst the luxuries of life, has now in many places climbed up on to the more exalted platform of necessaries, and it requires no great exercise of prescience to see that in a very short time any discontinuity in the supply of electrical energy will be little, if any, less inconvenient and dangerous to the community than failure of water service.

The public has only been persuaded to make itself thus increasingly dependent on electricity by the fact that our former fickle friend has been induced by firm, but gentle treatment, to develop that fundamental characteristic of civilisation, namely, trustworthiness. This delightful improvement, to which we owe the growth of central stations and the expansion of electrical business, is due principally to the energy and devotion to duty of our central station superintendents.

It is my distinguished privilege to be personally acquainted with a considerable number of these gentlemen, and I have no hesitation in saying that it would be difficult to mention any class of men who do better work for less money, or even as good work for as little money. It is notorious that a very considerable proportion held on to their positions principally for the advantage of getting experience, and particularly in municipal stations, receive the emolument in cash merely as an honorarium. But this arrangement, at its best, cannot be considered as a satisfactory basis on which to build up a great and important public service. This view has been illustrated in several cases during the present year. The electric lighting committees in several places, desiring to get the best men have by advertising tempted good men to change their billets; but the electrical infant, no more than the human infant, is likely to be benefited by a change of nurses, and one is led to wish in the interest of the infants, as well as of their nurses, that the latter were, as far as practicable, by better payment, rendered content with their positions and prospects.

Of course we can scarcely blame municipal councils for endeavouring to run what they are pleased to call experimental installations on an economical basis, but the large number of autumn extension orders which are coming in this year, with more than usual impetuosity, testify to the fact that the experimental stage has given place to the permanent and practical.

Take the case of a town using, say, 500,000 units per annum (there are several of this size, including Bradford), the addition of only one-tenth of a penny to the total cost would amount to over £200 per annum, which would obviously (to those who understand these matters) make a substantial addition to the engineer's salary without the slightest suspicion of injury to the ratepayers.

Up to the present, companies have paid better salaries than corporations, but I feel sure ratepayers will not be anxious to allow intelligent and painstaking servants to be tempted away from them by private enterprise.

Apologising for the length of this letter, which I venture to think is justified by the importance of the subject,

John S. Raworth.

September 23rd, 1895.

The Choice of Transformers.

Your contributor, Mr. Geo. Adams, in his article entitled "The Choice of Transformers" in your issue of September 20th, has been very unfortunate in his choice of an English transformer to compare with the American article. He takes a 1,500-watt transformer as having an iron loss of 79 watts. The standard iron loss in the 1,500-watt transformers manufactured by a leading English firm is 40 to 45 watts, and they have no difficulty in getting down to the lower figure with a frequency of 83 ~; at 125 ~ it would be much lower.

I think Mr. Adams is in error when he states that altering

the transforming ratio from 2,000/100 to 1,000/100 would halve the iron loss.

To alter the ratio as above, a new primary of one-half the number of turns and twice the sectional area of wire would be required; and, consequently, both volts and turns being halved, the induction and iron loss would remain as before. If what Mr. Adams states were true, a 10 or 20,000-volt transformer would be a most inefficient piece of apparatus.

Apologising for trespassing on your valuable space,

S. R. C.

September 21st, 1895.

The I.E.S. Accumulator.

Some time last year I had a single cell given to me by a friend, who told me it was made by the International Electric Storage Company. I used it for some time, when it unfortunately got broken, and to such an extent, that it was beyond repair. I had obtained some very long runs with a little lamp I used with it that I weighed the active material of the positive plate, and found that it turned the scale at a little over 13 ounces. I had obtained from this cell nearly 20 ampere hours.

This result I thought extremely good, but it struck me that it was due to the peculiar character of the peroxide which, though very porous, and with a very large surface, was as hard as Portland cement after it had been out of the acid a few minutes.

I have never seen any peroxide like it before; it looked like puce-coloured loaf sugar with a coarse grain, and gave off a very strange smell.

Vidi.

Information Wanted.

I have been told that an American engineer named Woolf has a process for preparing peroxide of hydrogen by electricity.

If any reader of your paper could inform me where I could get a description of this I should be much obliged.

Sam. Hobbs.

13, Ilfracombe Buildings, Marshalsea Road, S.E.,
September 20th, 1895.

The Lighting of Galway.

My attention has been drawn to a letter from Mr. J. E. Pearce in your paper of the 13th inst. Mr. Pearce is, as he explains, an "Undertaker" under "The Galway Electric Lighting Order," and according to my ideas, he is, with the other "Undertakers," unlimitedly liable. But he is in no way, as he has the right to say, if he thinks it worth the trouble, responsible for my opinions.

Mr. Pearce was not connected with the works during the first year; we got our order during Mr. Pearce's first year, but we commenced lighting before his connection with the scheme. When Mr. Pearce left at the end of three years, I understood it to be on account of financial disagreement, and the reason given in his letter is somewhat of a surprise. His capital interest in the concern is much greater than mine, and it seems odd to an outsider that he should go away and leave me to make ducks and drakes of a valuable property.

The quarrels of "Undertakers" in business uniform cannot be edifying. I have not sought publicity, nor do I desire to continue to fight my side.

I am willing to have our differences settled by the arbitration of some common friend, or by a friend of the "Undertakers," as far as they can be so settled; but it seems hopeless to expect to revive the old mutual admiration of the end of the first year when Mr. Pearce joined me, or of, indeed, within three months of the end of the fourth year when he "withdrew" from me.

James Perry.

County Surveyor's Office, Galway,
September 23rd, 1895.

BUSINESS NOTICES, &c.

Agency.—Messrs. Girdlestone & Co., of 16, Davies Street, Berkeley Square, W., have been appointed sole London agents for Messrs. J. P. Hall & Co., of Oldham, for the sale of their specialities in dynamos, engines, turbines, projectors, &c.

Business Announcement.—Messrs. Julius Harvey and Co., engineers and contractors for electric light and other machinery, have opened offices at Mansion House Chambers, 11, Queen Victoria Street, E.C.

Bankruptcy Proceedings.—The first meeting of the creditors and contributories concerned under the failure of Ronald A. Scott, Limited, was held on Tuesday last at the offices of the Official Receiver for the Brentford district, Temple Chambers, E.C. As there was not a quorum of creditors present at either meeting, no resolutions could be passed; therefore it was decided to adjourn the meetings for a fortnight.

Afterwards the adjourned meeting of the creditors of Ronald A. Scott was held, when a creditor asked if there was any distinction between Mr. R. A. Scott and Ronald A. Scott, Limited. The Official Receiver replied that Mr. Scott turned himself into a company in July, 1894, and the creditors who had supplied goods after that date would have to prove against the company, instead of against Mr. Scott. Not that it made any difference, as, in either case, there was not much prospect of any dividend being paid. In Mr. Scott's case, the whole of his furniture and effects were taken over by the company when the company was formed, so that he has now practically nothing, and in the case of the company, the whole of the assets were covered by certain debentures. If the creditors could upset those debentures they might then look forward to receiving some kind of a dividend. The debtor said he thought the company had agreed to take over his liabilities as well as the assets. The Official Receiver said the company only consisted of the seven signatories to the memorandum and articles of association, but they had fulfilled the requirements of the law by holding the statutory meeting. In reply to the Official Receiver, the debtor said the business had been practically carried on in the same way as a company, as when he carried it on privately; the only difference was, that he marked off the books, and Messrs. Reeves, his solicitors, and solicitors for the debenture-holders, had inspected the books every week or so, to see how the company was going on. Messrs. Reeves held £1,000 worth of debentures in respect of money lent. They held no security for their bill of costs, and in fact they had never rendered him an account of their costs. The reason he formed himself into a company was because Messrs. Reeves told him it would facilitate further capital being put into the concern. He denied having formed himself into a company for the purpose of giving further security to Messrs. Reeves and their clients in respect of the money they had advanced. As a matter of fact, Messrs. Reeves had introduced several gentlemen, who were all men of means, but after various interviews with them, it had all ended in nothing. Debtor further stated that he became aware of his failure in December last, although he did not really think himself insolvent then, if his assets could have been realised as a going concern. In reply to a creditor, the Official Receiver said he could lodge his proof at any time before the declaration of the dividend, but to use a political term, that matter was not "within the range of practical politics." The debtor said he wished the creditors to understand that he had not benefited by turning himself into a company. He always understood that the company was going to discharge all his debts, in consideration of his transferring all his assets to the company. The company had a lien on certain patents in connection with advertising by electricity, and if they could be sold for a reasonable sum, everyone would be paid in full. The estate was left with the Official Receiver for summary administration in the usual way.

Catalogues.—The General Electric Company, Limited, have just issued new catalogues of their electric bells and telephones. These catalogues, like former editions, contain a large number of illustrations and much descriptive matter, but they are really carefully compiled, practical treatises, on the two branches of the electrical trade. The electric bell catalogue includes signalling apparatus, various classes of bells, bell pulls and pushes, indicators, switches, alarms, wires, and a great quantity of accessories used in electric bell work. There are also at the end diagrams and instructions for fitting up, also estimates. The telephone catalogue, as might be expected, shows receivers, transmitters, microphones, and complete systems, and also describes the Stanley telephone systems, switches, switchboards, batteries, bells, conductors, alarms, insulators, and other accessories. The catalogues are very useful compilations.

A set of illustrated price sheets of switches, switchboards and cut-outs, and lampholders, has been brought out by the Universal Electrical Fittings Company, Limited, of Sheffield.

Country Installations.—Amongst the more recent installations carried out by Messrs. Bennett & Druce, of Preston, are comprised the lighting of eight large sheds at the Salford Docks, the lighting of St. Joseph's Catholic Church, with gas engine, dynamo, and battery; the lighting of Colonel Ormrod's mansion at Scorton, together with a complete set of cooking and heating apparatus; the fitting of a 15-H.P. electric hoist at the Preston Co-operative's Society warehouse, and the lighting of Messrs. Pyke's corn-mills at Preston. The above comprise a total of about 3,000 lights, mostly with engines, dynamos, and storage batteries, and in one case a 15-H.P. boiler, besides numerous smaller installations in various parts of Lancashire. The firm have recently opened a branch office in Belfast.

Jaques & Sons and Thornton v. Hemming & Co.—These actions, by holders of first and second debentures, came on Tuesday before Mr. Justice Hawkins—sitting as Vacation Judge—upon an application that Mr. Thompson, who had been appointed interim receiver, might be continued as receiver and manager of the defendant company, who carry on at Birmingham the business of electrical engineers. Mr. Marten, Q.C., for the company, submitted that the proper person to manage the business was Mr. Hemming, the present manager. His Lordship appointed Mr. Thompson as receiver and manager in both actions, with liberty to act at once, and to raise and pay the wages next week, the amount of the wages being, it was stated, £14 or £15. To the appointment was attached the usual condition that the person appointed should not continue to act as manager for more than six months without the leave of the Court.

Liquidations.—The first meetings of creditors and contributories in the New British Electric Installation Contractors, Limited, are to be held at the Official Receiver's offices, 45, Copenhagen Street, Worcester, on October 1st, at 2.30 and 2.45 p.m. respectively.

Lowcock, Hill & Co., Limited, is to be wound up voluntarily, resolutions to this effect having been passed on August 30th and September 17th at Manchester. Mr. A. S. Brewis, of 60, King Street, Manchester, is the liquidator. Creditors are required to send particulars of their debts or claims to Mr. Brewis by October 28th.

New Book.—The Cambridge University Press will shortly publish "Elements of the Mathematical Theory of Electricity and Magnetism," by Prof. J. J. Thomson.

New Firm.—Mr. R. F. Venner and Mr. A. M. Sillar, M.I.E.E., have entered into partnership as representatives of engineering and electrical firms, and will in future act as sole agents for Hookham's electricity meters for the United Kingdom (Birmingham and district excepted), and as London agents and sole country agents for the Nalder & Harrison Construction Syndicate. The London office and show room is at 10, Delahay Street, Westminster.

The Disaster on Board ss. "Iona."—The United Asbestos Company, Limited, write to us drawing attention to a method whereby such frightful disasters as occurred on the ss. *Iona* may be greatly limited or altogether averted. "The risks of fires in saloons or state-rooms could be greatly minimised, if not eliminated, if the partitions and ceilings were covered with asbestos 'Salamander' embossed decorations, which are absolutely non-inflammable and capable of being coloured to taste to any extent. In the case of lamp and store rooms, where decorations are not required, ignition of woodwork could be readily prevented by lining the walls and ceilings with asbestos millboard, or constructing same entirely of specially prepared asbestos plates composed chiefly of fibrous asbestos, so indurated as to be suitable for partitions or ceilings, and requiring scantling only to support them in position. The advantage which may be confidently claimed for the use of these articles on board ship would be, that in case of fire in any cabin protected in the way described, there would be little if any risk of it spreading beyond the point at which it commenced, and in this way the danger would be enormously reduced, and the fire much more easily extinguished. Allow us to add, that the same suggestions are equally applicable to buildings, particularly to warehouses, stores, factories, and workshops, where the contents render the chances of fire great."

ELECTRIC LIGHTING NOTES.

Balham.—Messrs. J. D. F. Andrews & Co. recently wrote to the Board, stating that Mr. J. Brown, the owner of the new shops in Hildreth Road, has put down electric plant to light the outside of such shops, and asked for permission to open the road to lay an electric cable from one side of the street to the other, but the Board decided not to grant such permission. The Brush Electrical Engineering Company wrote giving notice of intention to sink trenches and build boxes for the purpose of laying electric light mains in the Broadway, Lower Tooting.

Bradford.—The additional plant, which was ordered some time since, is now being laid down at the electricity works in preparation for the coming winter.

Brandon.—The Brandon and Byshottles Urban District Council has asked the Corlett Electrical Engineering Company, of Newcastle, to report upon and estimate for the lighting, by electricity, of the main roads and streets of their district.

Bray.—The Commissioners are applying for a provisional order.

Brighton.—It is stated that the extensions in the street lighting will be inaugurated during the month of November. The new installation will comprise about 50 standard arc lamps and 70 bracket pattern lamps. The increase in the number of consumers for four years is given as follows:—157 in 1892; 336 in 1893; 720 in 1894; and 970 for the year ended September 16th, 1895.

Cardiff.—At a meeting of the Lighting and Electrical Committee of the Cardiff Corporation last week, a deputation of tradesmen in the High Street Arcade attended to ask that the Arcade should be lighted by electricity. The borough engineer was instructed to prepare estimates of the cost of carrying out the work.

The Corporation has decided to light the Market with incandescent instead of arc lamps. The initial cost is stated as about £50 more, but a saving is anticipated of 3s. per hour.

Denbigh.—The Edison-Swan Electric Light Company has offered to lease an electric lighting station and plant for the town, and supply light at the rate of about 4s. per 1,000 feet of gas if the town would erect the station, which would cost £6,000 on the 30 years' purchase, at the termination of which time the whole system would become the property of the town. The Edison-Swan Company provide all the plant, engines, &c. The matter is being considered.

Dundalk.—The Town Commissioners are to consider on October 23rd whether to apply for an electric lighting provisional order for the borough.

Dover.—The new School of Science, Art, and Technology, which has been erected by the Dover Corporation, is lighted throughout with electricity.

Exeter and the Electric Light.—The Council of the "ever faithful" city had under consideration last week a recommendation from a committee that an offer should be made to the Exeter Light Company to purchase their works and undertaking for £7,500. This offer was based upon estimates prepared by the city engineer (Mr. D. Cameron), and Dr. Fleming, who was called in to advise. The value fixed by Mr. Cameron was £7,556, and by Dr. Fleming £7,536. After discussion, the report was adopted by 21 votes to 10. It was decided that the offer should be made subject to the approval of the Board of Trade, and to the sanction of the Local Government Board to the borrowing of the money.

Folkestone.—Mr. F. H. Medhurst, whose name our readers will remember in connection with Folkestone electric lighting matters, has requested payment of his account for his electric lighting report, for £55 18s. 1d. Some objection was raised to the sum being paid, and the matter was, we understand, referred to a committee.

Germany.—The Stettin Electric Lighting Company has just issued its report for the financial year 1894-95. It shows that the company is now supplying current to 10,171 incandescent lamps, 512 arc lamps, and 36 electromotors, the respective figures at the end of the preceding year being 8,390, 397 and 29.

Hull.—There were 57 applicants for the post of electrical engineer. A committee will decide upon three to go before the Council. The assistant engineer has resigned his post and taken a position at Bradford. Mr. Baston, one of the improvers at the station, takes his place.

Heaton Norris.—A committee is considering the lighting question, and whether the Council shall apply for a provisional order.

Hampstead.—Mr. W. H. Preece, C.B., F.R.S., has submitted his account for balance of commission for services rendered in connection with the electric light installation, amounting to £1,353 18s. 6d. The Electric Light Committee have caused the whole of the staff to be insured at the rate of 5s. per cent. on the annual wages paid, such rate including injuries arising from electric shock.

The Vestry recently threatened the London and Hampstead Battery Company with proceedings for non-compliance with the bye-laws made by the London County Council under the London Overhead Wires Act, with reference to the wires placed by them over and along the public streets in this parish. The company admitted they were in default, and upon payment of the costs, the summons was withdrawn, the Battery Company undertaking to comply with the bye-laws within seven days. The Vestry has empowered the engineer to order another plant, similar to the large unit at present in the station, at the estimated cost of £2,343. He has also been empowered to order certain materials, &c., among them being a number of house service boxes at 35s. each. The Vestry has also resolved that no pupils or improvers would be allowed to be taken on at the station in future. Instructions were given for an electric motor to be obtained for the chaff-cutting machine at the stoneyard, from the General Electric Company, Limited, at a cost of £24 3s. 9d., and it was also decided to obtain and fix a Blackman electrical ventilator in the board-room of the Vestry Hall.

Killarney.—For the installation of the electric light at the Asylum, 20 tenders were sent in, varying from £957 to £3,195. It is recommended that the tender of Messrs. Ferguson & Co. for £957 be accepted.

Liverpool.—Negotiations are still progressing between the Corporation and the Electric Supply Company for the purchase of the company's undertaking. The Corporation had the matter before them on 17th inst. The dissolution of the late Parliament has caused delay.

London.—The electric light will soon be installed at St. George's Cathedral, and it will probably be in use in October.

All Saint's Church, Margaret Street, is now lighted by electricity.

Mill Lighting.—A new woollen mill, which is to be erected at Holmfoot for Mr. James Scott, of Kilncleuch, will be lighted by electricity.

Morecambe.—The District Council has decided to offer the Morecambe Electric Light and Power Company £4,000 for its undertaking, upon certain stipulated conditions.

Newquay.—The Newquay Baths and Sanitary Steam Laundry Company are lighting their premises by electricity, their own machinery being used for motive power purposes.

Nottingham.—There was an interesting ceremony here on 20th inst. to celebrate the first anniversary of the electric light works. Sir John Turney, the chairman of the Electric Lighting Committee was presented with a gold key.

Norwich.—There was a slight failure in the private electric supply last Saturday evening.

Reading.—The new County Theatre is lighted by electricity. It was opened on Monday last week.

Shoreditch.—Nine tenders were sent in for insulated electric mains and conductor and drawing-in boxes. The tenders were referred to the Electric Lighting Committee.

Southport.—To-day the extension of the electric light works will be brought into operation. The new plant includes two 250-H.P. engines, two 125-unit dynamos, one 250-H.P. boiler, two sets of rectifiers. With this new plant the works have now a capacity of 12,500 8-CP lamps, whereas before it was only 4,133. The following were the contractors for the various works connected with the extensions:—Engines and steampipes, Messrs. John Musgrave & Son, Limited, Bolton; dynamos, main switchboard, arc light switchboard, and rectifiers, Messrs. Ferranti, Limited, London; boiler, Messrs. Edward Heaton & Sons, Manchester; condensing plant, Messrs. Browett, Lindley & Co., Limited, Patricroft; economisers, Messrs. Roberts Bros., Manchester; chimney, Messrs. Partington & Sons, Oldham; engine and boiler house, Messrs. H. and A. E. Connard, Southport, brickwork, and Messrs. Blanchard & Son, Southport, woodwork, slating, plumbing, &c.; and ironwork, Messrs. Edward Wood & Sons, Manchester. The new lamps were of the Crompton-Pochin pattern, supplied by Messrs. Crompton & Co., the pillars being cast by Messrs. McKenzie, of Edinburgh.

Sunderland.—The electric lighting of the Ryhope Lunatic Asylum of the Sunderland Corporation is now completed. About 700 incandescent lamps are employed, supplied by a generating plant consisting of two direct coupled Belliss engines and Parker dynamos. Steam is furnished by three Lancashire boilers, which also supply the service by means of which the building is warmed. There is also a battery of D.P. accumulators. The laundry machinery is driven by an electromotor, and there are several other motors employed for ventilation and for distributing the hot air by which the various wards are heated. Messrs. Edmundsons, Limited, were the contractors for the whole of the electrical installation, while the boilers and heating apparatus were supplied by Messrs. Ashwell and Nesolt. The electrical installation has been carried out under the superintendence of Mr. G. T. Hine, the architect, and of Mr. A. A. C. Swinton, the consulting engineer.

Tintwistle.—Inquiries are being made by a specially appointed committee to obtain information *re* the lighting of the village by gas or electricity. The feeling of some of the councillors, however, is that electricity is too expensive for the place.

Tunbridge Wells.—On 19th inst. the electric current was switched on to the Town Hall for the first time. It is stated that Tunbridge Wells is to be *en fête* on the occasion of the opening of the new central station by Lady Salomons next month, and there is to be a procession of all the local bodies round the borough.

Wolverhampton.—The Stafford *Advertiser* is responsible for the statement that there was a temporary breakdown of the electric light machinery a few days ago; the lamps in the Market Hall, Free Library, and various shops suddenly went out, and it was nearly two hours before matters were put right.

ELECTRIC TRACTION AND MOTIVE POWER NOTES.

Australian Electric Tramway Working at a Loss.—A Sydney paper says that the Waverley-Randwick electric tramway, has been working at a loss, and is not paying half the working expenses. It is therefore proposed to run it by some other motive power.

Bristol Tramways.—The Bristol Tramway Company recently submitted plans of, and asked for the approval of the District Council to, a scheme for extending their line from the terminus near the King's Arms to near the top of Warmley Hill, in order to gain access to premises including car shed accommodation, which would be put up upon property recently purchased by the company. The Council gave their consent conditionally.

Electric Traction in Brussels.—Quite an extensive system of electric tramways is being gradually established in Brussels. It is now reported that contracts have been let for the construction of a line between Sehonbeek and the Bois de la Cambre, a distance of about five miles. The line will be on the Thomson-Houston overhead conductor system.

Electric Traction in Austria and Hungary.—Messrs. Kremenezky, Mayer & Co., of Vienna, have just secured a preliminary concession for a local electric railway between Liebenau and Böhm-Aicha. An electric tramway has lately been completed and put in operation in the town of Pressburg.

Electric Traction in Germany.—Messrs. Schuckert and Co., of Nuremburg, have just acquired the property of the Augsburg Tramways Company, with the view of converting the tramway into an electric line. A company is to be formed, with a capital of £100,000, to take over and operate the electric tramway when completed.

Electric Traction in Spain.—Plans have been prepared, and an application for a 60 years' concession made to construct and operate an electric tramway between Chiclana, San Fernando, and Cadiz.

Light Railways for Ireland.—Under the provision of the Light Railways Act (Ireland) no fewer than 11 lines have now been completed, and are opened for traffic, and the Collooney and Claremorris line, about which difficulties arose as to the junctions at the terminal station, is almost completed, and will be opened this year. As an indication of what the State has helped Ireland to do in the matter of light railways, it may be mentioned that the 11 lines already opened vary in length from 48¼ miles at Galway and Clifden, and 26¾ miles at Killorglin and Valentia, to such short lengths as Balimore and Skibbereen 7¾ miles, and Ballina and Killala 8 miles.

Light Railways.—It is stated that a syndicate has been formed to carry into effect proposals for the construction of a light railway through the Gower peninsula, which extends over 20 miles westward from Swansea, and has at present no railway communication beyond Killay.

A public meeting was held at Glenisla on 19th inst. to consider a proposal to lay a light railway from Alyth to Glenisla and Braemar. The question of electricity *versus* steam was referred to by one or two speakers, but the only decision arrived at was that the meeting pledged itself to support such a scheme.

Port Elizabeth Tramways.—The *Financial Times* understands that Port Elizabeth Tramway Company has changed hands, and it is now proposed that the old system should be replaced by electric cars, similar to those in use at Birmingham. The price received by the vendors was £20,000.

Rumoured Experiments with Electric Traction.—Regarding a rumour that has been current the last week or so, the *Financial News* says: "There can hardly be much foundation for the report that a syndicate proposes to take over the Chatham Company's Metropolitan Extension line from Ludgate Hill to Victoria, to experiment with electric traction. Were the line an independent fragment, such experiments might be possible; but, seeing that a considerable part of the Chatham's main line traffic, both from Victoria and Holborn Viaduct, runs over it, and that the Midland and Great Northern run through trains from their suburban stations to Victoria, it is somewhat difficult to see how the various interests could be reconciled with the introduction of electricity."

The City and South London Electric Railway.—The *City Press* says that owing to the limited space at their terminal station at the Monument, the company have secured Parliamentary powers for the purpose of extending the line to Moorgate Street, and making an intermediate station on a site close by the church of St. Mary Woolnoth, at the corner of Lombard Street. In order to carry out these extensions, it is expected that the construction of another tunnel under the Thames will be found necessary, and that on its way to Moorgate Street it will be made to pass under the present one.

TELEGRAPH AND TELEPHONE NOTES.

Liverpool Telephones.—The Liverpool Health Committee has given consent to the Post Office authorities to erect poles for telephone wires in certain streets.

New Telegraph Cable.—The Mersey Docks and Harbour Board has given notice that during the present month an electric telegraph cable will be laid from Formby light vessel to Crosby lighthouse.

The Post Office Telegraphs.—The Postmaster-General's forty-first annual report (for the year ended March last) on the Post Office, has just been issued, and contains the following particulars *re* telegraphs:—"During the year under review 71,589,064 telegrams of all kinds were forwarded in the United Kingdom, an increase of 689,566, or 97 per cent.; 58,907,408 of these were ordinary inland messages; 5,937,715 foreign telegrams were dealt with, an increase of 255,890; but there was a decrease of 178,905 in the number of Press messages. The deficiency on this department during the year amounted to £452,803, as compared with £477,327 in the previous year. The postal and telegraph services together showed an increase of £341,000 in receipts, and of £274,000 in expenditure, or a financial improvement of £67,000."

Telegraphic Communication with Glasgow.—At a specially convened meeting, held on Monday, of the Home Affairs Committee of the Glasgow Chamber of Commerce, the question of the alleged insufficient telegraphic communication between Glasgow and London was brought up by Mr. Charles Seligmann, and, after discussion, it was unanimously agreed to make strong representation to the Postmaster-General to provide adequate and increased facilities. A memorial to this effect will be at once presented.

Telephony v. Travelling.—Of all the charges brought against the telephone, the one contained in the following paragraph extracted from a London daily is, perhaps, the most amusing:—"A Mexican newspaper urges that the further development of the telephone industry should be stopped, as it will ruin railways and hotels by rendering travelling unnecessary." This suggestion is on a par with that of a Yankee who suggested that the development of electric traction should be hindered because it lowered the price of horseflesh. If the telephone will enable users to avoid all-day or all-night railway journeys to the north, and elsewhere, and the expense connected therewith, it may be considered capable of looking after itself and working out its own development even more rapidly than formerly, in spite of all that a Mexican newspaper may say, and even in the presence of railway races to the north and to the south.

Telegrams for South Africa.—The following extract from the *Scotsman* of the 18th current doubtless refers to the Aden-Zanzibar cable, which was interrupted on the 2nd of this month:—"Great inconvenience has been caused in business circles in London by the break in the Eastern Telegraph Company's cable to the Cape. It is fully a week since the fracture took place, and messages, instead of occupying about two hours between London and Johannesburg, have been taking nearly two days. During the progress of a mining boom, such as has been going on in the Kaffir Circus for some time, the interruption of the telegraph cable is a very serious matter, and some attribute to this cause the slight set-back in South African mines which took place last week. The Eastern Telegraph Company's repairing steamer has been in the locality of the fracture for a few days, and has succeeded in getting hold of one end of the cable, and it is hoped the other will be fished up without delay, so that direct telegraphic communication may be resumed before the end of the week."

Telegraphic Cable for Japan.—The Central News learns that the Japanese Government has ordered 800 miles of submarine cable from the Telegraph Construction and Maintenance Company, this, it is understood, being intended for effecting telegraphic communication between Japan and Formosa. The most surprising part of the business to British submarine engineers is, that the Japanese have determined to lay the cable themselves, and it will be shipped to them in sealed tanks by chartered ships. The Japanese Government are having a cable ship built in this country, so that they will be soon in a position to lay and repair their own cables.

CONTRACTS OPEN AND CLOSED.

OPEN.

Ashton-under-Lyne.—Tenders are invited for an electric light installation for Wagstaffe's Steam Preserve Works, Hurst Brook, Ashton-under-Lyne.

Banstead and Colney Hatch.—September 30th. The Asylums Committee of the London County Council is inviting tenders for various works in connection with certain temporary iron structures which are to be erected for them. The list includes a fire alarm and telephone system, also heating arrangements at their asylums at Banstead and Colney Hatch. Particulars from R. W. Partridge, Clerk of the Asylums Committee, 21, Whitehall Place, S.W.

Bedford.—October 8th. Tenders are wanted for the supply and delivery of 200 cast-iron lamp-columns, carriers, and globes for the Electric Lighting Committee. Details can be obtained at the office of Mr. T. S. Porter, clerk, Town Hall, Bedford.

Belfast.—September 28th. Tenders are invited for the supply and erection of two direct-coupled steam engines and dynamos, battery of accumulators, main switchboard, and installation of about 232 incandescent lamps, complete, for the lighting of Belfast Lunatic Asylum, for the Commissioners for the Control. Particulars from Mr. O. A. H. M'Cowen, Chapel Lane, Belfast.

Belgium.—October 10th. The municipal authorities of Tongres are inviting tenders for the concession for the public and private electric lighting of the town. Tenders are to be addressed to the Administration Communale, Tongres, Belgium.

Berlin.—October 10th. Tenders are invited for the supply of three horizontal compound steam-engines, seven tubular boilers (on the Schulz-Knaudt system), and a travelling crane, for the Berlin Municipal Waterworks. Particulars from the Bauamt der Stadtischen Wasserwerke, Neue Friedrichstrasse 69 II., Berlin.

Blackburn.—October 5th. The Corporation invite tenders for electric lighting cables and accessories.

Braila.—October 2nd. The details regarding the tenders invited for electric tramways and lighting the city for the Municipal Authorities of Braila were given in our issue for August 30th.

Croydon.—October 8th. The Council invite tenders for wiring and for supplying and fixing electrical fittings at the new Town Hall, Courts, and Free Library. Particulars from Mr. Chas. Henman, 64, Cannon Street, London, E.C.

Dundalk.—October 7th. The Town Commissioners invite tenders for an electric lighting installation.

Egypt.—October 1st. The Municipal Authorities of Alexandria are inviting tenders for the concession to construct and operate, during a period of 50 years, a system of electric tramways in the town.

France.—Tenders are being invited for the supply of a regular current of electrical energy for an installation of about 1,200 lamps. Tenders to be sent to M. le Directeur du Grand Cercle, Aix-les-Bains (Savoie), France.

France.—October 10th.—Tenders are being invited for the supply of a quantity of paper-insulated cables in two lots. Tenders to be addressed to the Direction Generale des Postes et Telegraphes, 103, Rue de Grenelle, Paris.

Goole.—September 30th. Tenders invited until Monday next for fixing telephonic communication between Goole and Rawcliffe Bridge, a distance of about three miles, according to specification, for the Goole Urban District Council. Particulars from the Manager, Gasworks, Goole.

Harrogate.—September 30th. The Corporation invite tenders for the supply and erection of plant, including boilers, alternators, switchboards, transformers, meters, and overhead travelling crane for electric lighting installation.

Harrogate.—September 30th. Tenders are invited by the Corporation for wiring the new Montpellier Baths for electric lighting.

High Wycombe.—October 14th. The Chepping Wycombe Urban Sanitary authority invite tenders for working the electric lighting provisional order obtained by them within the borough, for a term of years and upon approved conditions. Tenders to be delivered to the Town Clerk, High Wycombe, from whom further details may be obtained.

Leicester.—October 12th. Tenders wanted for the erection, at their New Swithland reservoir pumping station, of four Lancashire boilers, each 27 feet 6 inches long and 7 feet diameter, for the Corporation of Leicester. Particulars from Mr. J. B. Everard, M.I.C.E., 6, Millstone Lane, Leicester.

London, W.—October 7th. Tenders are invited for the supply of stores from November 1st to October 31st, 1896, for the Great Western Railway Company. The following are some of the items: (9) Acids, alkalies, &c.; (10) oils, turpentine, &c.; (17) India-rubber goods; (18) telegraph instruments; (19) telegraph apparatus; (20) copper wire, G.P. wire, &c.; (21) telegraph ironwork and tools; (22) telegraph drysalteries; (23) carbons for electric light; (24) zinc, antimony, copper pipes, brass, &c.; (31) cast-iron pipes and rain-water goods; (40) tubes, iron and steel: (47) telegraph poles and yellow pine. Samples and patterns may be seen on and after 23rd inst. at the office of the Stores Superintendent, Paddington Station.

Rangoon.—November 4th. The Municipal Committee is inviting tenders for electric lighting. Particulars to be obtained from Messrs. Ogilvy, Gillanders & Co., 67, Cornhill, E.C.

Roumania.—October 2nd. The municipal authorities of Braila, Roumania, are inviting tenders until October 2nd next for the concession for (*a*) lighting about 64 kilometres of public streets by both gas and electricity, and (*b*) 64 kilometres of public streets by electricity alone. They are also inviting tenders for the concession for the construction and operation of a network of electric tramways in the principal thoroughfares of the town. Tenders to the Maire, Hotel de Ville, Braila.

Southmolton (North Devon).—Tenders invited for wiring the factory buildings for the electric light and ironing, including all the electric generating plant, for the Southmolton Shirt and Collar Manufacturing Company, Limited. The company find the power. Particulars of the Secretary.

Swansea.—September 28th. Tenders wanted for the supply of one 6-H.P. vertical steam-boiler, with fittings and mountings, for Swansea Workhouse for the Guardians. Particulars from the Master of the Workhouse.

Thetford.—October 5th. Tenders are invited for the supply of a new boiler (Cornish type), for the Town Council. Particulars from Mr. John Houchen, town clerk, Thetford. Tenders, sealed and endorsed "Thetford Waterworks, Tender for Boiler," must be delivered by October 5th.

Vienna.—November 14th. The Municipality of Vienna asks for tenders and plans for the construction and working of electric railways in and around the city. The notice may be seen at the Commercial Department of the Foreign Office.

CLOSED.

Ayr.—We stated last week that Messrs. W. G. Higgs and Co. had secured the contract for electric wiring of the municipal buildings and Messrs. Verity for the electric fittings. Messrs. Higgs now inform us that the complete order for both wiring and fittings was secured by them.

France.—A few weeks ago the General Direction of the French Posts and Telegraphs in Paris invited tenders for the supply of 100 tons of copper wire 4½ mm. in diameter. We now learn that the contract has been divided equally between the Compagnie Française du Bi-metal, and the Compagnie Française des Metaux, both of Paris.

Huddersfield.—From the tenders sent in for lighting by electricity the boot and shoe and confectionery departments, reading room, library, &c., in John Street and Albion Street, Huddersfield, for the Huddersfield Industrial Society, Limited, that of Mr. T. W. Broadbent, has been selected and accepted.

Ilford. — The contract for providing an electric call system to fire brigade staff, and telephone communication to Police Station for a term of five years, for the Ilford Urban District Council, has been given to the Consolidated Construction and Manufacturing Company, Limited.

Oldham.—The following tenders were sent in for wiring a portion of the Central Baths for electric lighting for the Corporation, Mr. S. Wilmott Newington being the borough electrical engineer:—

Baxendale & Co., Manchester (accepted) ...	£32	7	0
Bennett & Druce, Preston	34	0	0
James Crossley, Oldham	34	10	0
G. St. J. Day, Oldham...	35	0	0
Lomax, Kendal & Co., Manchester	37	13	6
Waring & Sons, Manchester	42	0	0
Charlesworth & Co., Oldham...	43	7	6
Fletcher, Hirst & Co., Burnley	45	7	6
Paterson & Cooper, London	47	0	0
Corlett Electrical Engineering Co., Wigan...	47	10	0
Sansome & Co., Blackpool	53	0	0

Sunderland.—The tenders sent in to the Town Council for electric light cables and electrical apparatus were from the following, Mr. C. S. Vesey Brown being the engineer:—

Cables: India-Rubber, Gutta Percha and Telegraph Works Company, Limited; Siemens Bros. & Co., Limited; Fowler-Waring Cables Company; W. T. Henley's Telegraph Works Company; W. T. Glover & Co.; British Insulated Wire Company, Limited (accepted).

Cast-iron work: Birtley Iron Company; Mackenzie Bros., Edinburgh; J. Shaw & Co., Glasgow; R. Maclaren and Co., Glasgow (accepted).

Stoneware: Doulton & Co. (accepted); Electric Construction Company, Limited.

Transformers: Siemens Bros. & Co., Limited; Johnson & Phillips; Brush Electrical Engineering Company, Limited; Crompton & Co., Limited; J. Fowler & Co.; Electric Construction Company, Limited (accepted).

Meters: British Thomson-Houston Company (accepted); Chamberlain & Hookham; T. Edmondson, Bradford.

NOTES.

City and Guilds of London Institute.—The evening classes at the Technical College, Finsbury, will recommence on Monday next, the 30th inst., when the introductory lecture of the advanced course on Electrotechnics (Lighting and Power) will be given by Prof. S. P. Thompson on rotating magnetic fields. The subsequent lectures of this course will be taken by Mr. O'Keeffe and by Prof. Thompson, who will take up special topics such as electric meters, design of alternate current machinery, &c. The Wednesday evening course by Prof. Thompson and Mr. E. Thomas will deal with the current, its measurement, and its application to the electro-magnet, &c. There will be the usual practical classes in the laboratories, and Mr. E. Roussean will later take up a laboratory class on electro-typing and electro-plating. In the department of Mechanical Engineering, Prof. Perry will give, in addition to the ordinary course on Practical Mechanics, a short special course on Thermo-dynamics as applied in Engineering, on Thursday evenings.

The Policy of the City Company.—Some of our readers may not go closely into our "City Notes," and for their benefit we quote the following remarks from the chairman of the Brush Company:—

In answer to a question as to whether the Brush Company had any representatives on the board of the City of London Company: Originally, he said, they had two representatives—the late Duke of Marlborough (then chairman of the Brush Company) and himself. When the Duke of Marlborough died he was not replaced, and he (the speaker), who was then their only representative, felt it his duty to withdraw from the board of that company, not especially in connection with their contract—although he felt they had been badly treated by the City Company—but because he dissented entirely from the policy the present engineer was carrying out in the interests of the City of London Company itself.

How it Strikes a Business Man.—Another remark of Mr. Braithwaite's is worth quoting. Speaking to the shareholders, he said:—

Now, I need hardly tell you, gentlemen, that among electrical engineers each one has his own particular view, and, therefore, you will readily understand that the change of engineers which took place in the City of London Electric Lighting Company in December last year was a very unfortunate thing for us.

Machine Telegraphy.—Mr. P. Delany, of multiplex fame, has recently put forward a scheme of "Machine" Telegraphy which is to "revolutionise" the present slow going methods of carrying on telegraphic business. There is nothing particularly startling in the form of apparatus with which he proposes to carry out his ideas; it comprises an automatic perforator (*à la* Wheatstone) which can be worked at a rate of 25 words per minute, and an improved Bain transmitter, which it is stated will, on an 850 lbs. copper wire between New York and Chicago (1,000 miles), work at the rate of 1,000 words per minute, and on shorter distances at a proportionately greater speed. We are at a loss to understand why Mr. Delany says: "Heretofore all transmitting machines for fast automatic telegraphy have employed a contact finger, brush or wheel, pressing on top of the perforated strip and making electrical contact through the perforations with a revolving wheel underneath the tape." Mr. Delany, we believe, is perfectly well acquainted with the Wheatstone transmitter, which in the Post Office has been worked at a rate of 600 words per minute, and does not use a brush or wheel contact; possibly, however, Mr. Delany does not classify this as a "fast speed" instrument. The general principle of Mr. Delany's apparatus is, in brief, the use of two brushes, one above and the other below the perforated slip, these two brushes making contact with each other at the perforations; there is thus no revolving wheel required. We do not doubt the possibility of the apparatus working on short circuit, or through a non-inductive resistance at a rate of 1,000 to 3,000 words per minute, but we have a very distinct recollection of a somewhat similar apparatus devised by Little, which worked at an almost equally high speed, but which when tried between London and Glasgow succeeded in doing but *thirty* words per minute! Though we may have doubts as to the capability of Mr. Delany's apparatus to do all that is claimed for it through long lines, even as heavily wired as he suggests, there is, we think, a good deal of truth in the assertion that "the telegraph of the future will comprise substantial poles, a few large copper wires, and rapid automatic systems capable of utilising the full carrying value of the conductor." It is quite true that "telegraph properties, as now constituted, consist of poles loaded down with cheap wires, and operated manually, by systems necessarily slow." Mr. Delany's general plan (for America) of automatic telegraphy, is as follows:—The company working the system should not compete for stock or exchange business requiring instantaneous transmission and delivery, but should seek the less urgent business of greater volume, and at rates which would secure at once a large share, and eventually the greater portion of the correspondence now conducted through the mails. Instead of maintaining hundreds of branch offices, involving great outlay, there should be but one central station, located close to the general post office in each city. Messages could be sent to these central stations from any part of the cities, or from points adjacent, through the mails, in the ordinary way. Each sender of a message would enclose the requisite tolls in stamps issued by the company, and which would be on sale at drug stores and other places throughout the city. A uniform tariff, 50 words for 15 cents, and 1 cent for each additional five words, or fraction thereof, would be charged. A message placed in an envelope directed to the central office of the company, and dropped in any post box within the city limits, would reach the telegraph office, on an average, within an hour. It would be transmitted and dropped in the General Post Office at the other end within 10 minutes, and would be delivered by the postman within an hour thereafter. Thus letters would be collected, transmitted and delivered, on an average, within two hours, for 15 cents, as against about 30 hours at a cost of 2 cents, or 12 cents if an extra 10 cent stamp is used. As the single telegraph station would be located in the centre of the business district in each city, special delivery by the company's messengers could be made for 5 cents extra charge, thus reducing the time for a telegraph letter and reply to about an hour, which is much quicker than the average time necessary for the ordinary services at present.

The Institution of Junior Engineers.—On Friday next, October 4th, at 8 p.m., at the Westminster Palace Hotel, the annual general meeting is to be held to receive the council's report, elect officers for ensuing session, &c.

Fires.—On the evening of the 19th inst. a slight fire occurred at the premises of the National Telephone Company, Royal Exchange Square, Glasgow. The fire was stated to be caused by a spark from a chimney close by, igniting the gutta-percha covering the telephone wires on the roof.

Very late one night, towards the end of last week, a fire broke out in the Palace of Electricity of the Bordeaux Exhibition. The wood had been heated by the strong sun of the past few days, and burnt quickly. At 20 minutes past 12 the whole building was a sheet of flame, and the machines were destroyed. The firemen were, however, able to save the electric pianos, some toys, and minor exhibits.

Electro-Harmonic Society.—Members should bear in mind that the first concert of the season will be held to-morrow (Saturday).

Aluminium.—In a recent issue the *Western Electrician* stated that a review of the mineral sources of the United States will be shortly forthcoming from the geological survey; among the other things treated it will show that the production of aluminium has increased from 83 lbs. in 1885 to 550,000 lbs. in 1894. Our contemporary details the various steps in the introduction and development of this material over there. The manufacture at present amounts to over $200,000, the price being about one-tenth what it was in 1888. The article is concluded thus:—"It has been claimed that aluminium would be available as a valuable material in the construction of naval vessels. This claim was urged so strongly and brought so persistently before the officers of the navy that they decided to make tests of the metal. Specimens of aluminium were submitted to tests in salt water, and the naval officers who have examined these specimens say that the metal will not be available for use in the construction of naval vessels, because, after being in salt water for any length of time, it crumbles to pieces. It cannot withstand the action of salt water, and it is believed that only one metal known to science will thoroughly do this, and that is copper."

An Important Question at Leicester.—The electricians of Leicester have our sympathies in their attempts to induce the Town Council to let fall a few crumbs from the municipal electric lighting table. The local firms of electricians have memorialised the Council, asking it to seriously consider the action of the Electric Lighting Committee in connection with the trade of fitting electric light installations. The Corporation, they stated, had created a competition between themselves and the petitioners, which threatened to overwhelm their trade as contractors, and was stifling that healthy competition between local electricians which would otherwise exist for the benefit of the public. They therefore prayed that the Committee might be instructed to refrain from competing with the local trade in fitting electric light installations. The petition was referred to the Committee.

St. Pancras Vestry and Electric Lighting—We reproduce the following correspondence which has just appeared in the *Times* regarding the electric lighting at St. Pancras:—

Sir,—Within the last few days an innovation in the supply of electricity has been quietly introduced which may have a very marked effect on the future of electric lighting. The Vestry of St. Pancras have doubled the pressure at which they supply the current, and, although probably all supply companies will ultimately do the same, one is entitled to protest against the suddenness of the change in this case, as it is certainly prejudicial to the public interest. Very few of the manufacturers and others interested have been properly advised, and as there has so far been no demand for 220-volt fittings and appliances there are none on the market. Until a sufficient time has elapsed for suitable fittings to be designed and produced, there will be a very grave risk of extinction, damage, and perhaps fire, on 220-volt circuits. As far as the lamps are concerned, 8 candle-power can no longer be used; the 16 candle-power is the smallest size obtainable, and that is expensive, ugly, and altogether untried in performance. Time alone will enable the makers to perfect and produce what is required, and surely the authorities are not warranted in increasing the capacity of their mains, when in order to do so they sacrifice the public convenience, and perhaps safety, by not giving ample notice of their intention to make so radical a change.

We are, Sirs, yours obediently,

HANDCOCK & DYKES.

Westminster Chambers, 5, Victoria Street,
London, S.W., *September 18th.*

The following is the reply from Mr. Sydney W. Baynes, the St. Pancras chief engineer:—

Sir,—Had your correspondents applied to me at the Vestry Hall for information on this matter it would have been to their advantage, as they are evidently very far from being up-to-date regarding high voltage lamps and fittings. It may interest them to know that I have had such lamps in constant use for 18 months, and for the past seven months they have been installed in the premises of customers supplied from one of the most prominent and successful stations in the country, with excellent results. No alterations in the fittings or wiring have been needed. The ordinary tumbler switch, good porcelain cut-outs, well insulated wire, combined with good workmanship, have long since proved thoroughly efficient and safe in carrying even a still higher voltage than that to be introduced at St. Pancras. 8-candle-power lamps at 230 volts are in the market, and Mr. Stearn, the joint inventor with Mr. Swan of the incandescent lamp, is to the front with a high voltage lamp of 6-candle-power. Your correspondents could never have seen a properly constructed 220-volt lamp, or they would not have stigmatised it as ugly, seeing that the best makers turn out a lamp in no outward respect different from the 110-volt lamp, which, like the original 50-volt, will in time become a matter of ancient history.

Those who best understand the subject and its importance on the future of electric lighting are the most desirous of co-operating to render the movement I have introduced thoroughly popular and successful. Yours truly, SYDNEY W. BAYNES, *Chief Engineer.*

St. Pancras Vestry Hall, N.W.

In yesterday's issue of the *Times*, the two following letters also appeared:—

THE ST. PANCRAS VESTRY AND ELECTRIC LIGHTING.

Sir,—The discussion on the subject of increased pressure for the electric supply and some possible objections to it which was opened by the letter of Messrs. Handcock & Dykes, in your issue of last Saturday, has a very practical side to it. As most of your readers are aware, the public electric supply has up to now been given in London and most provincial towns by one of two systems, either by the alternating current system, in which the electric energy is delivered at a high pressure to appliances called transformers, placed in the houses or in certain special localities, by which it is transformed down to currents of lower pressure for delivery to customers, or by the continuous current three-wire system in which a certain electric pressure, generally of 100 or 110 volts is maintained between the intervals of three insulated conductors laid in the ground. If, for simplicity, these three conductors are called A, B, and C, theoretically there should be 100 volts pressure between A and B and 100 between B and C, and all three should be insulated from the earth. As a matter of fact, it is difficult for the supply companies using mains of a certain type to preserve perfect insulation all over their systems of conductors, and if one of the outer conductors, say C, becomes "earthed," the other outer conductor, A, will be raised to a pressure of 200 or 220 volts above the earth. All electric fittings used in houses, such as lamp sockets, switches, motors, and the like, are, even on the present systems of electric supply, exposed to the chance of having to bear an electric pressure of 200 or 220 volts between some portions of them, and ought all to be so made and tested that they can stand this pressure safely. The question has been much debated whether there would be advantage or disadvantage in "earthing the middle wire" of the three-wire systems of supply; but it is clear that if any of the three-wire systems of electric supply propose to give a 200-volt pressure between each side of the system, making 400 over all, a more severe system of inspection and testing of ordinary house electric fittings will have to come into force. If, on the other hand, it is merely intended to extend in London the outer members of the three-wire system of conductors and to use 200-volt lamps in these outer districts of the supply area, then the state of affairs, electrically speaking, will be no worse than it is at present. J. A. FLEMING.

Electrical Engineering Laboratory, University College, London.

Sir,—We note Mr. Baynes' letter in your issue of to-day, which interests us, as we applied to certain well-known lampmakers and also manufacturers of fittings only a week ago, and they were no more up-to-date than we are. Surely it is scarcely right for a public body like the St. Pancras Vestry to recommend certain makers before other equally important ones have even been advised of their requirements.

It should be added that our thirst for knowledge led us to make inquiries at the vestry's Stanhope Street electric light station; but Mr. Baynes has evidently kept all these good things to himself, as the officials there surprised us by asking for the very information which we had come to seek.

Our previous letter makes it tolerably clear that we also wish to see the movement succeed, but do not agree with the method of initiation. From our past experience with 220-volt installations, we believe it to be the voltage of the future, but beg to repeat that in our opinion much of the existing wiring is unsafe at that pressure.

With reference to the performance of the lamps, a trial will easily settle the question. If Mr. Baynes will choose twelve 8 or 16 candle-power 220 volt lamps, we will also select an equal number of 100-volt lamps, these to be submitted to an independent expert for a comparative test as to life at a steady voltage and also with a voltage fluctuating 4 per cent. above and 4 per cent. below the normal, both sets of lamps to have an efficiency of 3·75 watts per British candle-power. We trust that Mr. Baynes will accept this challenge, as it will at once set the question at rest. HANDCOCK & DYKES.

Westminster Chambers,
5, Victoria Street, London, S.W.
September 25th.

An Electric Light Accident at Bristol.—Early on Monday evening a small fire occurred in one of the electric light sub-stations in St. James's Barton, Bristol. In an interview with a local pressman, Mr. H. Faraday Proctor, the electrical engineer, stated that the engineers were testing the new cables for the Stoke's Croft supply at three times their working pressure before permanently joining them up to the Stoke's Croft service, for which a cable runs into St. James's Barton transformer chamber, and then on again to the next sub-station at the bottom of Thomas Street, Stoke's Croft. For the testing purpose, temporary wires were laid across the sub-station from one end of this cable to the other to convey this extreme pressure, and as it was thought possible there might be some breakdown under such an extra current, the covers of the chamber were left off, and a man was left to watch while the pressure was on, and with directions to telephone to the central electric station if anything went amiss. Directly the pressure was got up at the works on Temple Back, the small fuses there burnt out, thus indicating that something had happened, and the foreman was immediately sent to the Barton sub-station. At the same time, a telephone message was received "that something had gone wrong," as smoke was issuing from the manhole of the transformer chamber. It was found that the temporary wires, being of India-rubber and a tar compound, the smoke which came from them had been excessive, and, in addition, some small pieces of wood caught fire. The supply was resumed by seven o'clock in the evening. The reports which have been published in the daily Press appear to be greatly exaggerated. We understand that there has never been an explosion, or a suspicion of gas, in any of the Bristol electric light boxes. The new cables referred to have, we are informed, since been tested to 6,000 volts, and found perfectly satisfactory.

"Drilled" to Death.—After being employed at a cable works in London for five years, Robert Alfred Cumber, aged 27 years, was dismissed at an hour's notice by the foreman. This sudden termination to by no means a short stay with the company so preyed upon the mind of Cumber, that he, a few days later, committed suicide by cutting his throat. We are not acquainted with all the details of the case, but the brief report of the inquest which is published in a morning paper contains no mention of any reason for the foreman's action, other than that he was "drilling him a bit," and meant to reinstate him in a few days. The foreman was possibly only exercising his proper authority if he acted thus with a view to making the man work more diligently when re-engaged, but the sad ending to the affair will doubtless incline him to act in future in a less playful manner with those under him, and especially comparatively old servants.

Obituary.—The death of Mr. Paul Prince, superintendent of the Midland Railway Signalling Department, occurred on Monday night, from cancer. Mr. Prince, who was only 45 years of age, was the originator of some of the most important electrical patents and improvements in railway engineering.

We much regret to have to record the death of Mr. J. R. Edwards, Postal Telegraph Superintending Engineer of the North Wales district.

We are also sorry to learn of the death of Sigismund Schuckert, the founder of the celebrated Schuckert establishments, which occurred, after a protracted illness, on September 16th. We shall refer further to this gentleman next week.

Electric Clocks.—Prof. Becker is entering upon a four months' experimental trial of the synchronising clocks, by which the Bazaar Committee of the Glasgow Town Council propose that a system of standard time should be supplied to the city. The clocks are to remain on trial for two months at the Observatory, and if the system proves satisfactory a further two months' public experiment will be made by the establishment in the centre of the city of a single circuit of clocks or street dials electrically controlled from the Observatory through a regulating clock which may be fixed in the Municipal Buildings.

The Portrush Tramway Fatality.—The Board of Trade inquiry was opened at Portrush on Wednesday regarding the late fatal accident on the Portrush and Giant's Causeway Electric Tramway. The investigation may be protracted, as many witnesses are to be examined.

CITY NOTES.

The Brush Electrical Engineering Company, Limited.

The sixth annual general meeting of this company was held at Cannon Street Hotel, on Monday last, Mr. J. B. Braithwaite, jun., in the chair.

The Chairman in going through the accounts said there had been no change during the year in the amount of the company's capital, which still remained at £450,000 of share capital and £125,000 of debenture stock. The creditors had been reduced during the year from £72,000 to £44,888, showing a reduction of £27,000; the loans and overdrafts from the bankers have increased from £25,000 to £78,000; the provision for depreciation of property, patent, and goodwill remains the same as last year, and the item of profit and loss account is fully dealt with in the report. The contingent liability in respect of uncalled capital on shares in other companies has been reduced during the year from £39,000 odd to £5,547; in other words, that amount has practically disappeared, because the £5,547 remaining is not likely to be called. On the credit side the property, patents, and goodwill account has been increased by additional plant during the year by £2,487, and after deducting the usual sum for the amortisation of the lease in Borough Road the item stands at £288,874. The stock in hand amounted to £100,829, the debtors stand at £141,432, the cash at call and at bankers' and in hand is £3,910, the shares and debentures in other companies at cost (less the amount written off) are £61,236, the liquidator's balances and suspense account amount to £1,963, and the balance of foreign and colonial branches account stands at £104,305. The chief item was the increase in the loans from the bankers from £25,000 to £78,000, which arose from two items, £27,000 of it was the result of reducing the amount due to creditors from £72,000 to £44,000 odd, and the remainder was due to an increase in the shares and debentures held in other companies, practically representing the difference between £39,697 liability on the shares they had last year and the £5,547 they now had. The gross profit had been £37,858, being a decrease of close upon £20,000 as compared with last year. That decrease, as already mentioned in the report, was due entirely to the difficulties which had occurred in connection with the contract with the City of London Electric Lighting Company. On the other hand, the expenses and general charges stand at £17,027, as against £19,974 last year, while the maintenance of the buildings and plant amounted to £2,708. With regard to the issue of the debenture stock, he stated last year that the loan of £25,000 from the bankers was likely only to be a temporary matter, and therefore it was not worth while to issue additional capital to liquidate it. What he said last year with regard to that applied with equal force to the amount which they now owed the bankers—£78,000—and for that reason they did not propose to make any permanent addition to the capital account of the company. It would be unwise to saddle themselves with a permanent charge for this additional £105,000 of debenture stock, which they proposed to issue. But on the other side of the balance-sheet there were assets, which are more or less liquid, and which might easily come in in the form of cash or shares, to the amount of £61,000, while the balance of debtors over creditors was £96,000, and the stock was worth £100,000, making a total of £257,000. If they did realise the whole of the stock and the whole of the difference between debtors and creditors, it would mean that their business had practically come to an end. At the same time, the balance of debtors over creditors was very much larger than it would be in a normal year's trading, owing to the fact of the heavy retention funds which they were obliged to allow to remain on some of the municipal lighting contracts. The balance might be reduced to £50,000, in which case they would have £50,000 in cash, and that, in addition to the shares and debentures which they were constantly realising, would give sufficient to redeem the whole amount of this debenture stock which they proposed to issue very shortly. They proposed to make the new stock redeemable at 105 per cent. at six months' notice at any time, in order to pay off their bankers, and give that amount of cash in hand which a company of standing ought to possess. At the same time, it is more than probable, unless some very unexpected extension of business took place in the course of the next two or three years, the whole, or a considerable portion, of that debenture stock would be redeemed under the provisions of the issue which he had mentioned. They were of opinion that the preference shareholders were entitled to the whole of the profits made during the past year up to the amount sufficient to pay their full dividend. The net profits were not enough to pay the full 6 per cent. on the preference shares, but they were sufficient to allow a further division of £2,000, and that distribution they proposed to make at the earliest possible date. The preference shares had a first charge over the ordinary shares to the extent of a full 6 per cent. dividend from the net profits of the year, but they are not cumulative as from one year to another. During this year we have earned £7,400 net, of which the preference shareholders have received £5,400. There is, therefore, another £2,000 odd to come to them, which they might receive next year, in addition to the ordinary dividend of 6 per cent. The first question they would want to hear about was the circumstances in connection with the contract with the City of London Electric Lighting Company, which had, unfortunately, turned what would have been the best year in the company's existence into the worst. Apart from that contract, the past year has been the best in the history of the company. The unfortunate result was entirely due to the extraordinary and unforeseen circumstances which had arisen in connection with the contract. He was not at liberty to go into the exact details; but he could give in very general terms sufficient reasons to enable them

to understand the position in which they had been placed. The contract with the City of London Electric Lighting Company was one of considerable magnitude, amounting in all to somewhere about £300,000, and under that contract the decision of all points connected with it was left absolutely to the engineer of the City of London Electric Lighting Company for the time being. That was a very usual provision, and, no doubt, would have been perfectly satisfactory under ordinary circumstances; but they had been unfortunate enough to have no less than three engineers in the course of the existence of the contract, each of whom, as he was appointed, became practically a supreme judge as to whether the contract was being carried out to his satisfaction or not. He need hardly tell them that among electrical engineers each one has his own particular views, and, therefore, they would readily understand that the change of engineers which took place in the City of London Electric Lighting Company in December last year was a very unfortunate thing for them when it turned out that the new engineer had very different views of what the obligations under the contract were to those which his predecessor had had. In view of the fact that the engineer was made supreme judge, there was practically no alternative before them but to accept the altered view of what were the obligations under the contract, or to resort to an expensive and probably ruinous lawsuit, and they made the best arrangement they could, although the result had had an exceedingly serious effect upon the profits. They had endeavoured to adjust matters with the new engineer of the City of London Electric Lighting Company on the basis that he wished, and this having been accomplished, work under the contract was again proceeding. They were in the fortunate position of having the works fully occupied with orders for some months in advance. They had carried out and opened central stations for electric lighting for the municipalities of Worcester and Leicester, and they had also opened for the County of London and Brush Provincial Company a station for the supply of electricity to Dover. All those works had turned out entirely satisfactory, and they had work of a similar character in hand for St. Luke's, Clerkenwell, and Wandsworth, for the County of London and Brush Provincial Company, and for various other stations, so that as regards the electrical shop, they were full of orders, and had plenty of work in hand. The car shops were also full of orders at the present time. They had been building locomotives and rolling stock for the Beira Railway, which was one of the new railways that had been constructed for the opening up of South Africa. They had also in hand a large number of cars for the Rouen Tramways Company, which are being equipped with electricity. In every department of the works they were well supplied with orders. With regard to the engine building side of the works, they had carried out a considerable number of orders. They hoped the new Raworth engine would bring considerable additional orders into the engine shop, and that it would be an engine which they could manufacture at a very considerable profit. With regard to electric traction—for electric traction was a thing that they must look to very largely in the future to keep the electrical engineering shops full—up to the present time, in Great Britain it had been practically a dead letter. At the same time, the thin edge of the wedge had been introduced into this country, and no doubt that when the three or four important tramway works that were now in course of construction were opened, and the public realised the immense convenience and the immense acceleration of travel which were due to the adaptation of electricity for the working of their tramways, they would see a very great rush of electric tramway business in this country. Therefore he might say the electrical industry had an enormous future before it in the direction of electric traction. Electric lighting was a firmly established industry, and was not likely to retrograde; but electric traction had a comparatively new field, and in that direction he looked to a large amount of work coming to us for our well-equipped car sheds at Loughborough. Having regard to the position in which the company has been placed by these unprecedented circumstances in connection with the City of London contract, he and his colleagues felt it would be the right thing to forego half their fees in the ensuing year. That would indicate a desire to do their best for the company in every way. He then moved the adoption of the report.

Mr. Ward wished to know whether the board considered the shares to be of full value. The report presented to them was the most unsatisfactory report they had heard. In every trading company losses were inevitable, but the loss incurred by that company during the year was not due to ordinary trading at all, and he could not help thinking that the directors made a considerable blunder in agreeing that the engineer to the City of London Electric Lighting Company should have the control of the whole matter. He had never heard of such a thing, although he had had a great deal of experience in contracts. The usual method of deciding these matters was for each party to appoint a representative, to whom disagreements might be referred. He trusted that in future the directors would be very careful as to the manner in which they entered into contracts of that kind, and especially contracts which involved an expenditure of £300,000.

Mr. Lamont asked the chairman if he could throw any light upon the fact that a few weeks prior to the issue of the report, the shares of the company had a sudden fall in their market price?

The Chairman, in reply, said that, after very anxious consideration on the point, the board believed that the shares were well worth the figure at which they stood in the balance-sheet. With regard to the City contract, he was not responsible for the negotiation of that contract, which was made before he became chairman of this company; but he thought it was very probable he should have done the same had he been in the place of their then manager. It was impossible to foresee that they would have a change of engineers three times within as many years, and the circumstances were so extraordinary and unprecedented, that he did not think any reasonable amount of foresight could have avoided the present difficulty. He quite agreed that it was a most unsatisfactory form of contract, but it was the same form as that usually adopted, and was identical with the company's municipal contracts. He would also point out that if they did not take contracts on those terms their competitors would be only too glad to get them. With reference to there having been some apparent leaking out on the market of the probable purport of the directors' report, he could only say that this had been a matter of extreme annoyance to the managers and directors, and to himself particularly. They were engaged in investigating the matter, but, as yet, without tracing anything. It was extremely annoying, because it seemed to imply that those "in the know" had been taking advantage of their knowledge to realise shares at better prices than would be possible after the report was issued. That was a thing that would be absolutely dishonourable, and he did not think any language could characterise it too strongly. The drop in the market price taking place simultaneously with the issue of the report might be only a coincidence, but it looked rather remarkable. Naturally, the directors had done nothing such as had been suggested. He, personally, had increased his holding, because he considered their shares to be much below their intrinsic value. Regarding the interim dividend, of course, when that was paid everything was proceeding entirely satisfactorily; the whole of the loss that had arisen had occurred in the second half of the financial year. He imagined the shareholders would desire that no interim dividend should be paid on the ordinary shares; at any rate, that was the course the directors would probably adopt, unless the shareholders instructed them to the contrary.

In answer to a question as to whether the company had any representatives on the board of the City of London Company, the Chairman replied in the negative. Originally, he said, they had two representatives—the late Duke of Marlborough (then chairman of the Brush Company) and himself. When the Duke of Marlborough died he was not replaced, and he (the speaker), who was then their only representative, felt it his duty to withdraw from the board of that company, not especially in connection with their contract—although he felt they had been badly treated by the City Company—but because he dissented entirely from the policy the present engineer was carrying out in the interests of the City of London Company itself.

The report was then adopted.

Official Announcements re Companies.—Notification was published in Tuesday's *London Gazette* that the following companies, among others, have been struck off the register:—

Bicester Electricity Supply Company.
Boardman's Electric Sun Lamp Patents.
Central Electrical Company.
City of Waterford Electric Supply Company.
Dominion Electrical Company.
East London Electric Supply Company.
Electrical Finance Corporation.
Electro-Automatic Fire Extinguishing Company.
"Eston" Arc Lamp Syndicate.
Froggatt's Inventions Syndicate.
Gloucester Electricity Supply Company.
Hampstead Electric Light and Power Supply.
Middlesborough Electricity Supply Company.
Patent Electro-Magnetic Clock Syndicate.
Rochdale Electricity Supply Company.
St. John (Hampstead) Electric Supply Company.
Stoke-on-Trent Electricity Supply Company.

Also that the following companies will be struck off the register within three months, unless cause is shown to the contrary:—

Laing Electric Light and Power Company.
Lancashire and Yorkshire Electric Lighting Company.
Wynne's Electric Closed-Tube Tramways.

City of London Electric Lighting Company.—This company has announced that it having been found that the scale set forth in the circular dated January 31st may be in contravention of Clauses 19 and 20 of 45 and 46 Vic. (cap. 56), it has been cancelled, and the allowances (except the reduction in meter rentals) will not become operative.

Mr. J. Cecil Bull, the secretary and manager of this company, informs us that Mr. Joseph Bevan Braithwaite, jun., has resigned his seat on the board of the company.

TRAFFIC RECEIPTS.

The City and South London Railway Company. The receipts for the week ending September 22nd, 1895, **amounted to £881; week ending** September 23rd, 1894, £835; decrease, £4; total receipts for half-year, 1895, £10,148 corresponding period, 1894, £10,238; decrease, £90.

The Liverpool Overhead Railway Company. The receipts of this railway for the week ending September 22nd, 1895, amounted to £1,239; corresponding week last year, £955; increase, £284.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending September 20th, 1895, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, were £2,972.

SHARE LIST OF ELECTRICAL COMPANIES.

TELEGRAPH AND TELEPHONE COMPANIES.

Present issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1892.	1893.	1894.	Closing Quotation Sept. 18th.	Closing Quotation, Sep. 25th.	Business done during week ended Sept. 25th, 1895. Highest.	Lowest.
173,400£	African Direct Teleg., Ltd., 4 % Deb	100	...	4 %	4 %	102 —105	102 —105	...	...
1,912,880£	Anglo-American Teleg., Ltd.	Stock	£2 15s.	£2 11s.	£2 2s.	48 — 50	48 — 50	...	...
2,993,560£	Do. do. 6 % Pref.	Stock	£5 10s.	£5 2s.	£4 4s.	89 — 90	89 — 90	89⅞	89
2,993,560£	Do. do. Defd.	Stock	...	...	...	8¼— 9	8½— 9	8⅝	8½
130,000	Brazilian Submarine Teleg., Ltd.	10	6½% §	6½% §	...	13⅜— 14½	14 — 14½	14 7/16	14⅜
75,000£	Do. do. 5 %, Debs., 2nd series, 1906	100	5 %	5 %	...	111 —115	111 —115	...	...
44,000	Chili Telep., Ltd., Nos. 1 to 44,000	5	10%‖ §	... §	2½%	3¼— 4	3¼— 4	3⅜	3¼
10,000,000$	Commercial Cable Co.	$100	7 %	7 %	7 %	160 —165	160 —165	...	...
224,850	Consolidated Telep. Const. and Main., Ltd.	10/-	2 % §	2 % §	1½%	1/16— 3/16	1/16— 3/16	...	...
16,000	Cuba Teleg., Ltd.	10	8 %	8 %	8 %	13 — 14	13 — 14	...	...
6,000	Do. 10 % Pref.	10	10 %	10 %	10 %	20 — 21	20 — 21	...	...
12,931	Direct Spanish Teleg., Ltd.	5	4 %	4 %	4 %	4 — 5	4 — 5	...	...
6,000	Do. do. 10 % Cum. Pref.	5	10 %	10 %	10 %	9⅜— 10½	9⅜— 10½	...	...
30,000£	Do. do. 4½ % Debs. Nos. 1 to 6,000 ...	50	...	...	4½%	103 —106 %	103 —106 %	...	...
60,710	Direct United States Cable, Ltd.	20	3½% §	2⅝% §	2 %	9 — 9½	9 — 9½	9½	...
400,000	Eastern Teleg., Ltd., Nos. 1 to 400,000	10	6½% §	6½% §	6½%	17⅛— 17⅜	17⅛— 17⅜	17⅜	17⅛
70,000	Do. 6 % Cum. Pref.	10	6 % §	6 % §	6 %	18 — 18½	18 — 18½	18⅛	...
102,100£	Do. 5 % Debs., repay. August, 1899	100	5 %	5 %	5 %	106 —109	106 —109	...	...
1,297,837£	Do. 4 % Mort. Deb. Stock Red.	Stock	4 %	4 %	4 %	129 —132	129 —132	131½	128½
250,000	Eastern Extension, Australasia and China Teleg., Ltd. ...	10	7 %	7 %	7 %	17⅝— 18⅛	18 — 18¼	18¼	18
54,100£	Do. 5 % (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs. reg. 1 to 1,049, 3,976 to 4,326	100	5 %	5 %	5 %	102 —106	102 —106	...	...
194,300£	Do. do. Bearer, 1,050—3,975 and 4,327—6,400	100	5 %	5 %	5 %	103 —106	103 —106	104½	...
320,000£	Do. 4 % Deb. Stock	Stock	4 %	4 %	4 %	128 —131	128 —131	129½	129
80,600£	Eastern and South African Teleg., Ltd., 5 % Mort. Deb. 1900 redeem. ann. drgs., Reg. Nos. 1 to 2,343	100	5 %	5 %	5 %	102 —106	102 —106	104	...
107,600£	Do. do. do. to bearer, 2,344 to 5,500	100	5 %	5 %	5 %	103 —106	103 —106	...	...
300,000£	Do. 4 % Mort. Debs. Nos. 1 to 3,000, red. 1909	100	4 %	4 %	4 %	107 —110	107 —110	...	...
200,000£	Do. 4 % Reg. Mt. Debs. (Mauritius Sub.) 1 to 8,000	25	4 %	4 %	4 %	113 —116%	113 —116	...	...
180,227	Globe Telegraph and Trust, Ltd.	10	4⅞% §	4⅞% §	4¼%	10¼— 10½	10⅛— 10⅜	10 7/16	10 3/16
180,042	Do. do. 6 % Pref.	10	6 % §	6 % §	6 %	17 — 17½	17 — 17½	17 1/16	17
150,000	Great Northern Teleg. Company of Copenhagen	10	8⅜% §	8⅜%	8⅜%	21¾— 22¼	21¾— 22¼	...	...
180,000£	Do. do. do. 5 % Debs.	100	5 %	5 %	5 %	103 —106	103 —106	104½	...
17,000	Indo-European Teleg., Ltd.	25	10 %	10 %	10 %	50 — 53	50 — 53	52½	51½
100,000£	London Platino-Brazilian Teleg., Ltd. 6 % Debs. ...	100	6 %	6 %	6 %	104 —108	104 —108	...	...
484,597	National Teleph., Ltd., 1 to 484,597	5	5 % §	5 % §	5 %	6⅛— 6⅜	6⅛— 6⅜	6 5/16	6⅛
15,000	Do. 6 % Cum. 1st Pref.	10	6 %	6 %	6 %	16 — 18	16 — 18	...	...
15,000	Do. 6 % Cum. 2nd Pref.	10	6 %	6 %	6 %	15 — 16	15 — 16	15⅞	...
119,234	Do. 5 % Non-cum. 3rd Pref., 1 to 119,234	5	5 %	5 %	5 %	6⅛— 6⅜	6⅛— 6⅜	6⅜	6½
1,100,000£	Do. 3½ % Deb. Stock Red.	Stock	3½%	3½%	3½%	106 —108	106 —108	107½	106⅝
171,504	Oriental Teleph. & Elec., Ltd., Nos. 1 to 171,504, fully paid	1	...	...	4¼%	9/16— 11/16	9/16— 11/16	...	...
100,000£	Pacific and European Tel., Ltd., 4 % Guar. Debs, 1 to 1,000	100	4 %	4 %	4 %	108 —111	108 —111	...	...
11,839	Reuter's Ltd.	8	5 %	0 %	*nil*	4 — 5	4 — 5	...	...
3,381	Submarine Cables Trust	Cert.	...	...	...	127 —132	127 —132	129½	...
58,000	United River Plate Teleph., Ltd.	5	...	...	...	2¾— 3¼	2¾— 3¼	...	...
146,733£	Do. do. 5 % Debs.	Stock	5 %	5 %	5 %	93 — 98	93 — 98	...	...
15,609	West African Teleg., Ltd., 7,501 to 23,109	10	..	...	*nil*	5½— 6½	5½— 6½	...	...
238,300£	Do. do. do. 5 % Debs.	100	5 %	5 %	5 %	104 —107	104 —107	...	...
30,000	West Coast of America Teleg., Ltd.	10	...	...	...	1 — 2	1½— 2	1⅝	..
150,000£	Do. do. 8 % Debs., repay. 1902	100	8 %	8 %	...	99 —104	99 —104	...	...
64,248	Western and Brazilian Teleg., Ltd.	15	2½%	2½%	3 %	10 — 10½	10 — 10½	..	...
33,129	Do. do. do. 5 % Pref. Ord. ...	7½	5 %	5 %	5 %	6½— 7	6½— 7	7	...
33,129	Do. do. do. Def. Ord.	7½	...	...	1 %	4 — 4½	4 — 4½	4¼	4
165,200£	Do. do. do. 6 % Debs. "A," 1880 Red.	100	6 %	6 %	6 %	102 —106	102 —106	...	...
206,400£	Do. do. do. do "B," do.	100	6 %	6 %	6 %	102 —106	102 —106	...	...
88,321	West India and Panama Teleg., Ltd.	10	½%	⅞%	½%	⅜— 1	⅜— 1	...	...
34,563	Do. do. do. 6 % Cum. 1st Pref.	10	6 %	6 %	6 %	10½— 10⅝	10½— 10⅝	10 7/16	10½
4,669	Do. do. do. 6 % Cum. 2nd Pref.	10	6 %	6 %	6 %	8½— 9½	8½— 9½	...	...
80,000£	Do. do. 5 % Debs. No. 1 to 1,800 ...	100	5 %	5 %	5 %	110 —113	110 —113	112½	...
1,777,000$	Western Union of U. S. Teleg., 7 % 1st Mort. Bonds ...	$1000	7 %	7 %	7 %	113 —118	113 —118	...	...
164,300£	Do. do. 6 % Ster. Bonds.	100	6 %	6 %	6 %	100 —103	100 —103	...	...

ELECTRICITY SUPPLY COMPANIES.

30,000	Charing Cross and Strand Electy. Supply	5	5 %	4½%	4½%	5¼— 5⅜	5¼— 5⅜	5 5/16	...
10,277	*Chelsea Electricity Supply, Ltd., Ord., Nos. 1 to 10,277 ...	5	...	...	...	7 — 7½	7 — 7½	7⅝	...
60,000	Do. do. do. 4½ % Deb. Stock Red. ...	Stock	...	...	...	116 — 119	116—119	...	...
40,000	City of London Elec. Lightg. Co., Ltd., Ord. 40,001—80,000	10	...	...	5 %	14 — 15	13½— 14½	14⅞	13⅞
40,000	Do. do. 6 % Cum. Pref., 1 to 40,000	10	6 %	6 %	6 %	15 — 16	14½— 15½	15⅞	15⅜
300,000	Do. 5 % Deb. Stock, Scrip. (iss. at £115) all paid	...	5 %	5 %	5 %	133 —137	133 —137	135½	134
22,475	County of London and Brush Prov. Elec. Ligtg., Ltd., Ord. 1—22,475	10	...	...	...	8½— 9½	8½— 9½	9⅛	...
10,000	Do. do. do. 6% Pref., £4 pd., 40,001—50,000	10	...	...	...	6⅞— 7½	6⅞— 7½	7½	...
50,000	†Liverpool Electric Supply, all paid	5	5 %	5 %	5½%	7⅞— 8⅛	7⅞— 8⅛	...	...
49,900	*Metropolitan Electric Supply, Ltd., 101 to 50,000 ...	10	2 %	2½%	3 %	12¼— 12⅝	12 — 12½	12⅝	12
150,000£	Do. 4½% first mortgage debenture stock	...	4½%	4½%	...	117 —119	117 —119	...	...
6,452	Notting Hill Electric Lightg. Co., Ltd.	10	...	...	1 %	8½— 9½	8½— 9½	9	...
19,980	St. James's & Pall Mall Elec. Light Co., Ltd., Ord., 101-20,080	5	7½%	4½%	6½%	8¼— 8⅜	8¼— 8⅜	...	...
20,000	Do. do. 7 % Pref., 20,081 to 40,080	5	7 %	7 %	7 %	9 — 10	9 — 10	...	...
67,900	*Westminster Electric Supply Corp., Ord., 101 to 60,000 ...	5	3½%	4 %	5 %	8⅝— 9¼	8⅝— 9¼	9 1/16	8⅞

* Subject to Founder's Shares. † Quotations on Liverpool Stock Exchange.

Unless otherwise stated all shares are fully paid. ‡ Dividends paid in deferred share warrants, profits being used as capital

Dividends marked ‖ are a year consisting of the latter part of one year and the first part of the next.

SHARE LIST OF ELECTRICAL COMPANIES—*Continued.*

ELECTRICAL RAILWAY, MANUFACTURING, AND INDUSTRIAL, COMPANIES.

Present Issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1892.	1893.	1894.	Closing Quotation, Sept. 18th	Closing Quotation, Sept. 25th.	Business done during week ended Sept. 25th, 1895. Highest.	Lowest.
90,000	Brush Elecl. Enging. Co., Ord., 1 to 90,000...	3	6 % §	6 % §	...	1½ — 1¾	1½ — 1¾	1¾	1¹¹/₁₆
90,000	Do. do. Non-cum. 6 % Pref., 1 to 90,000	2	6 % §	6 % §	...	1⅞ — 2	1⅞ — 2⅛	2 1/16	1⅞
125,000*l*	Do. do. 4½ % Perp. Deb. Stock.... ...	Stock	4½%	4½%	...	111 —114	111 —114	112½	...
630,000*l*	City and South London Railway	Stock	6%	6%	1¼%	38 — 40	38 — 40	...	...
28,180	Crompton & Co., Ltd., 7 % Cum. Pref. Shares, 1 to 28,180	5	7 % §	7 % §	...	1 — 2	1 — 2	1¼	...
89,261	Edison & Swan United Elec. Lgt., Ltd., "A" shrs, £3 pd. 1 to 89,261	5	...	...	5 %	2 — 2½xd	2 — 2½	...	...
100,000	Do. do. do. 4½% Deb. Stock Red....	Stock	...	...	4½%	104 —107	104 —107	...	...
110,000	Electric Construction, Ltd., 1 to 110,000	2	*nil*	*nil*	*nil*	⅝ — ⅞	⅝ — ⅞	...	...
12,845	Do. do. 7 % Cum. Pref., 1 to 12,845 ...	2	7 %	7 %	7 %	2¼ — 2⅜	2¼ — 2⅜	2 7/16	...
91,195	Elmore's Patent Cop. Deposg., Ltd., 1 to 70,000	2	*nil*	*nil*	...	¾ — 1	¾ — 1	...	...
69,385	Elmore's Wire Mfg., Ltd., 1 to 69,385, issued at 1 pm. ...	2	*nil*	*nil*	...	⅞ — 1⅛	⅞ — 1⅛	...	...
20,000	Fowler-Waring Cables, Nos. 301 to 20,300	5	*nil* §	*nil* §	...	¼ — ⅜	¼ — ⅜	...	...
9,600*l*	Greenwood & Batley, Ltd., 7 % Cum. Pref., 1 to 9,600 ...	10	7 %	*nil*	...	6½ — 7½	6½ — 7½	...	...
10,000	Henley's (W. T.) Telegraph Works, Ltd., Ord.	10	5 %	5 %	6 %	12¼ — 12⅜	12½ — 13	12 15/16	12⅝
3,000	Do. do. do. 7% Pref.	10	...	...	...	15 — 16	15 — 16	15⅜	...
50,000	Do. do. do. 4½ Mort. Deb. Stock	Stock		...	...	104 —107	104 —107	...	...
50,000	India-Rubber, Gutta Percha and Teleg. Works, Ltd. ...	10	12½%	12½%	10 %	19 — 21	19 — 21	20⅛	19¾
200,000*l*	Do. do. do. 4½ % Deb., 1896	100	4½%	4½%	4½%	102 —104	102 —104	...	...
37,500	†Liverpool Overhead Railway, Ord.	10	...	1 %	1½%	12⅞—13⅛	11⅝— 11⅞	...	...
10,000	† Do. do. Pref., £10 paid	10	...	5 %	5 %	15 — 15½	15 — 15½	...	...
37,350	Telegraph Constn. and Maintce., Ltd.	12	15 %	20 %	20 %	43 — 45	43 — 45	44⅜	43¼
150,000	Do. do. do. 5 % Bonds, red. 1899	100	5 %	5 %	5 %	104 —107	104 —107	...	...
54,000*l*	Waterloo and City Railway, Nos. 1 to 54,000, £4 paid ...	10	...	...	...	4½— 4¾	4½— 4¾	4⅝	...

† Quotations on Liverpool Stock Exchange. ‡ Unless otherwise stated all shares are fully paid. ¶ Last dividend paid was 50% for 1890.

Dividends marked § are for a year consisting of the latter part of one year and the first part of the next.

CROMPTON & Co.—The dividends paid on the ordinary shares (which have not a Stock Exchange quotation), are as follows: 1892—0%§; 1891—7%§; 1890—8%§.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

Birmingham Electric Supply Company, Ordinary of £5 (fully paid), 5⅜—6¼.

Electric Construction Corporation, 6 % Debentures, 95—100.

House-to-House Company (£5 paid), 4—4½.

Do. do. 7 % Preference, of £5, 8—8½.

Do. do. 4½% Debentures of £100, 108—110.

Kensington and Knightsbridge Electric Lighting Company, Limited, Ordinary Shares £5 (fully paid) 8—8½; 1st Preference Cumulative 6 %, £5 (fully paid), 7—7½.

Liverpool Electric Supply, £5 (fully paid), 7⅜—8¼

London Electric Supply Corporation, £5 Ordinary, ⅜—½.

Yorkshire House-to-House Electricity Company, £5 Ordinary Shares fully paid, 6¾—7.

Bank rate of discount, 2 per cent. (February 22nd, 1894).

THE SUPERIORITY OF ALTERNATING OVER CONTINUOUS CURRENT FOR INCANDESCENT GLOW LAMPS.

By C. J. ROBERTSON.

It has for some time been an established fact that with continuous currents there is a difference of potential in the vacuous space between the two conductors of an incandescent electric lamp. The experiments of Edison, Preece, Fleming and others, have conclusively shown this phenomenon, which is now generally called the "Edison effect." Besides this effect there can also be observed, especially at very high incandescence, a glow at the inner negative pole or conductor (generally called mount) of a glow lamp. The extent of this depends upon the state of, and the residual constituents in, the vacuous space, the amount of voltage, the degree of incandescence, and the width of separation of the two conductors inside the lamp. This apparently static glow can be changed from one mount to the other by simply reversing the polarity of the continuous current. I find the greater part of these glowings are caused by residual hydrogen remaining in the bulbs from various causes; such as the Pt wire being heated by the glassblower's hydrocarbon flame, the nature of the preparation of the filament, and the imperfect dryness of the residual vacuous space are all causes of these glowings.

The H and other gases are very observable at the negative pole, and are found there from what must be an electrolytic separation of the residual gases.

Recent experiments that I have made in the course of the manufacture of lamps, and special experiments, all confirm my first belief that each of these effects must be indicative of, or causes of, deleterious changes going on in the lamp. The natural sequence was to try these experiments with alternating currents, and the result is that the first effect, "Edison effect," vanishes, and the second, "static glow," cannot be obtained with alternating currents, except that there is an indication at excessively high voltages, and this is then seemingly an electrical evaporation. Also with alternating currents, the tendency of the lamp to suddenly short circuit (or to explode, as it is often called) is greatly diminished, and is almost impossible in ordinary practice and with good lamps.

Another beneficial effect of using alternating currents is, that with capped (plastered) lamps there are no electrolytic effects set up between the plaster and the metal parts of the cap, which is especially liable to occur with continuous currents, and with lamps in damp climates or situations. In the case of lamps installed under either of the latter conditions and fed by continuous current, there is a gradual lowering of the insulation resistance of the cap, and this is a plentiful source of premature breakage of the lamp, or at least the destruction of the cap.

The following experiments, which I carried out on a very large scale, that is to say, with many successive tests on about 30,000 lamps, completely show the superiority of alternating over continuous currents for glow lamp lighting.

Whilst managing a large glow lamp factory in Vienna, I commenced a system of "up-keep" ("pauschaul") for a fixed price per lamp per 1,000 burning hours. In this price was included the finding of the original lamps, the lamp renewals, and the payment for the current used by the lamps. This system is only commercially possible when one first knows the following points:—

1. The most economical efficiency at which to run the lamps at each installation, this being based on the prices of current and lamps and their duration at various efficiencies.

2. The average life of the lamps at these most economical efficiencies.

3. The mean ampères or watts taken by each class of lamp during its life.

4. The total watt or ampère hours indicated on the customer's watt hour or ampère hour meter.

Having three or four, one is independent of how long or how many of the total lamps installed are burned during each 24 hours, &c.; for these, of course, always provide the total average lamp hours or burning hours. To obtain 1 and 2, I carefully photometered and numbered each lamp, the results being entered in a separate book for each installation. Twice the installed number of lamps (preferably all of one candle-power, or, at least, of a fixed proportion of 8, 16 and 32 C.P. lamps) were initially supplied to each customer. After the first 100 hour period, all the original lamps of each installation were taken down, and reserve lamps were installed. The former lamps were returned to the works, where they were re-photometered, and the results entered in the special books. In this way the whole of the lamps were treated for each successive period of 100 hours, and the tests were continued until the whole of the 30,000 lamps were used up. Those lamps which had lost more than 20 per cent. of their candle-power were considered broken, and were not returned to be re-run. All these experiments were made on lamps of 2 and 2½ watts per candle, which were the most economical efficiencies for the various sizes of installations, owing to the charges for current being subject to large discounts for large consumers.

It so happened that about half of our customers were supplied with alternating current, 110 v. at 83 ~, from the mains of the International Electric Company (Ganz & Co.'s system), and the remainder were supplied with continuous current from the mains of the Austria General Electric Company (Siemens and Halske's system) at 110 v. The results of all these tests proved that the lamps on the alternating circuits broke less and retained their original candle-power better than those on the continuous current circuits, notwithstanding the fact that the variations of pressure on the alternating circuits were 7 per cent., and those on the continuous were only 5 per cent., and also notwithstanding the fact that the duration of the maximum voltage was greater with the former than with the latter. These voltage tests were made both with recording instruments, and by numerous separate tests on the various consumers' premises.

ELECTRO-MOTOR FRAUDS.

The mystery which surrounds electrical and magnetic phenomena in the popular mind has naturally been taken advantage of to the full by fraudulent inventors. The Keely motor is a well known example. In a recent number of *Cassier's Magazine*, Dr. Henry Morton tells the story of another fraud of this kind which some twenty-five years ago was brought out in the United States, and succeeded for some time in deceiving several business men and even the editor of a technical journal. The machine was apparently operated by a few cells of an ordinary galvanic battery, and developed a capacity for work equal to several horse-power, with a consumption of zinc about 3 ounces for 2½ horse-power continued for 9 hours. As described by the editor of the New York *Journal of the Telegraph*, who was a firm believer in the invention, the machine consisted of an iron circular frame of about 18 inches diameter, and 5 inches wide on the periphery. Five equidistant apertures were cut on the periphery of this iron case, and into these the ends of five electro-magnets were inserted. On the armature, inside the case, were fixed six magnets, which were acted upon successively by the electro-magnets fixed to the case. The battery driving the motor consisted of four bichromate of potash cells. On the shaft of the armature was placed a belt pulley, from which by belting and a countershaft a circular saw was driven.

When the battery circuit was closed, great rapidity of motion was at once acquired, the floor of the room shaking violently with the power developed. Pieces of wood were sawn rapidly without apparently disturbing the rapidity or evenness of the motion. This rapid and effective action was watched for nine consecutive hours by investigating parties, without any perceptible decline of power being observed.

This deception was successfully carried on for some time, and considerable capital was invested in it by business men who had faith in the invention. Among those who made a visit to the motor was a young man then recently graduated from an engineering school, but who has since become one of the prominent physicists of the world, *i.e.*, Henry A. Rowland, now of John Hopkins University at Baltimore. Prof. Rowland described the results of his visit in a letter to the *Scientific American*. Calling with a friend at 12 o'clock, he was told that the motor was not then running, but would be in operation at one. Returning alone at one, he was shown through numerous passages into the second storey of a back building, where he was met by the illustrious inventor and a few select friends. The inventor first showed the model machines, which, being genuine electro-motors, apparently revolved with little power, as they could be easily stopped. The famous motor itself differed from the models in being enclosed in a cast-iron case, which enveloped it closely above, but spread out into a rectangular base below, which rested directly on the floor. The experiment of sawing wood was shown as already described, but it was observed that there was no change of velocity, whether the saw was working or not. The inventor explained this peculiarity by saying that the magnets were pulled closer to the armature when the saw was in action, and thus exerted a greater force, and was very angry when Rowland suggested that it would also work without variation if the power proceeded from a well-governed steam engine in the neighbourhood. Entrance to the room below was refused on the ground that it was rented to another man, but it was afterwards ascertained from the proprietor that this room, along with steam power, was let to the inventor of the motor, and that the motive power was stopped from 12 to 1 o'clock.

The inventor of the motor soon after disappeared, and the carcase of the motor was ferretted out by a reporter in a junk shop. The mystery was then discovered. Passages were found in the cast-iron frame through which a belt had passed to a pulley on the motor shaft from the shafting in the room below. The motor was, therefore, not running when the steam engine was stopped from 12 to 1 o'clock.

"This," says Dr. Morton, "was the end of this bubble, remarkable equally for its utter lack of rational foundation, and its success in misleading men who in their general business relations—and even, in some cases, in technical applications of electricity—occupied prominent places in the community, and deservedly enjoyed the respect and confidence of their contemporaries."

Such impudent frauds do not appear to prosper so well on this side of the Atlantic, though the recent attempts to resuscitate the Keely motor would lead us to suppose that the promoters of these enterprises imagine that there is a good field, even here, for their operations, if properly advertised. The perpetual motion man is also by no means rare in our midst, though these misguided enthusiasts are, as a rule, more often sinned against than sinning.

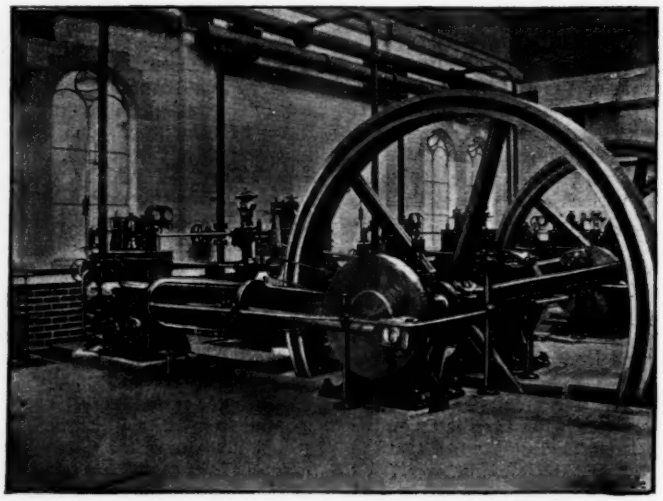
ELECTRIC LIGHTING OF STAFFORD.

As has been the case with a good many towns, the immediate reason why the Corporation of Stafford took up the electric lighting of the town was because a company endeavoured to get a provisional order. In June, 1889, the Midland House-to-House Company served notice on the Corporation that they intended applying for a provisional order. The Town Council held a meeting, and decided that, in order to keep command of the streets, they would, when the time came, apply for the order themselves. It was granted in 1890, and they then sent out circulars to those tradesmen who were likely to be customers. The replies being unsatisfactory, the matter was allowed to stand until May, 1893, when Mr. J. Ferguson Bell, the engineer and manager of the Corporation gas works, presented a report to the electric lighting committee, together with specifications of steam and gas-driven plant for the proposed generating station. Mr. Bell had for some time been going carefully into the question of using gas engines, and at the end of his very able report, says: "Gas engines are, in my opinion, certain to become one of

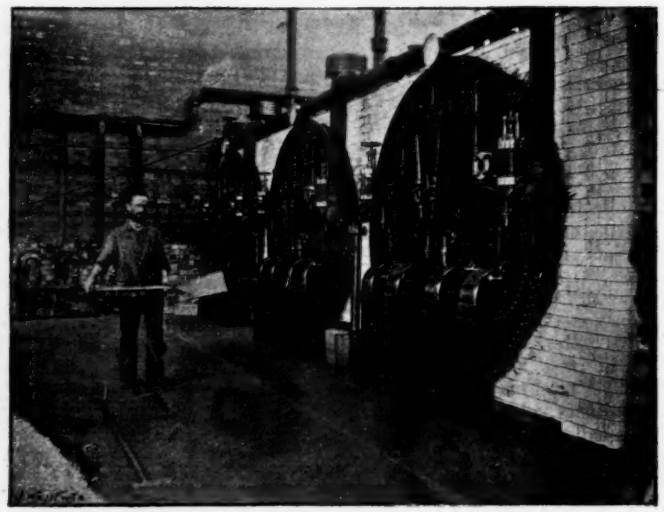
the prime movers in the near future; but it appears to me a question whether they are yet suitable for central station work where absolutely steady running is of the utmost importance. . . . . The initial outlay for steam or gas driven generating station of equal size would be practically the same, and I am inclined to recommend the former."

From the figures given, it would appear that the total cost of running the station with gas or steam plant is nearly the same, the figures working out for steam at 4·46d., and gas 4·86d. per Board of Trade unit generated; but by using producer gas instead of ordinary illuminating gas, the cost would be reduced to that of the steam plant, or perhaps slightly lower.

Dr. John Hopkinson, F.R.S., was called in as electrical adviser, and he endorsed Mr. Bell's scheme that the lighting be done on the low pressure three-wire system, with continuous current, the whole installation for 3,500 16-C.P. lamps to cost about £15,000. Powers were taken out for £20,000, and a site costing £500 was decided on close to the gas works. Dr. Hopkinson prepared specifications and drawings, which were sent out and reported on in the usual way.



View of Marshall's Engine.



Boiler House.

Buildings.

Mr. J. F. Bell designed the buildings, which are complete in themselves, and are without the temporary built end for extensions that one so often sees in the provinces. They are handsome in appearance, and it is almost a pity they were not on some more public highway. The engine room and offices are faced internally with white and coloured glazed bricks, and the outside appearance is relieved by the blue brick and stone facings which are used here and there for strengthening the structure. The roof principals are of steel throughout; the ties are of rectangular section, and there are no welds anywhere. All the joints are rivetted.

The chimney, which cost £500, has a square base and a round shaft; it is 132 feet high, and 7 feet 3 inches across inside at the bottom, and 6 feet at the top, being lined one-third of the way up with 4½-inch fire brick. The floors of engine room and offices are tiled with Minton tiles by Maw and Co., Shropshire. As the station is built on a bed of peat, pitch pine piles, 40 feet long, and 11 inches square, had to be driven right through into the gravel underneath; longitudinal timbers laid across the piles support a bed of concrete, 3 feet thick and 8 feet wide, and this in turn carries the footings for the walls of brick worked in with cement. The foundations for the engines were piled for separately; the concrete blocks on which they and the dynamos stand are quite separate from the walls. All this work was done by the Corporation.

Contractors.

Buildings, Messrs. Lovatt & Co., Wolverhampton; boilers, Messrs. Hick, Hargreaves & Co., Limited; economiser, Messrs. Green & Co., Wakefield; engines, Messrs. Marshall, Sons & Co., Limited; dynamos, the Electric Construction Company, Limited; switchboard, the Electric Construction Company, Limited; accumulator and stand, Chloride Electrical Storage Syndicate, Limited; electric mains, Messrs. Siemens Bros. & Co., Limited; overhead traveller, Mr. Thomas Smith, Rodley; water softener, the Maignens Filter Company; electric meter, Messrs. Ferranti & Co.; ejector condensers, Messrs. Korting Bros. & Co.; centrifugal pumps and motors, Messrs. J. and H. Gwynne; Cameron steam pump for tank, Messrs. F. Pearn & Co.; feed pumps for boilers, Messrs. C. & J. Weir, Cathcart, Glasgow; iron roofing, Messrs. Rubery and Co., Darlaston; trenches for mains, Mr. C. J. Nevitt, Stafford; steam injectors, Patent Exhaust Steam Injector Company; steam pipes, Messrs. J. Russell and Co., Wednesbury; branch piping for engines, &c., Messrs. Marshall, Sons and Co., Limited; steam pipe covering, Messrs. Leroy and Co., Lower Broughton, Manchester; exhaust pipes and overflows, mains, Messrs. W. G. Bagnall and Co., Stafford; floor plates round engines, Messrs. W. G. Bagnall & Co., Stafford; floor tiling, Messrs. Maw & Sons, Shropshire; boiler mountings, Messrs. Hopkinson & Co., Huddersfield.

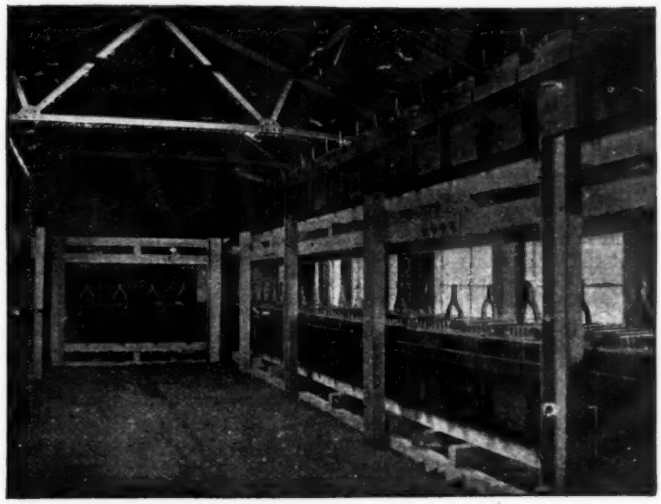
Boiler House.

The coals and coke are brought right up to the stokehole in trucks. There are three Lancashire boilers, each fitted with Meldrum's patent furnace, and blowers for forced draught, the fire bars of the furnace being $\frac{1}{8}$th inch apart, so that the breeze will not drop through. The boilers are 7 feet 6 inches diameter and 28 feet long, with flues 3 feet diameter, fitted with four conical welded cross tubes of $\frac{3}{8}$-inch steel, about 5½ inches diameter at the small end. The thickness of the plates of Siemens-Martin steel is as follows:—

Cylindrical shell	$\frac{5}{8}$ inch.
Flue tubes except end rings ...	$\frac{1}{2}$ "
End rings of flue tubes	$\frac{9}{16}$ "
End plates	$\frac{5}{8}$ "
Outer cover strips	$\frac{5}{8}$ "
Inner cover strips	$\frac{7}{16}$ "
Gusset plates	$\frac{9}{16}$ "

The normal working pressure is 125 lbs. per square inch, and they are provided with a duplicate feed-water ring main with two branches to each boiler; and cross connected

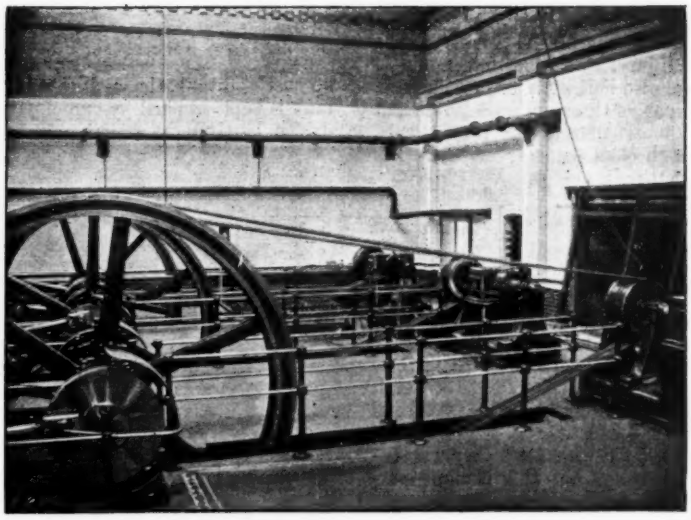
"Giffard's" steam injectors. Steam required for the engines in the gas works will in future be supplied by these boilers, for which the gas department will pay about £200 per annum, and supply the small coke screenings for firing the boilers free of charge. Coal will be burnt during the hours of greatest load. The economiser is of Green's latest type, containing 192 pipes arranged in two groups, this giving space amongst the pipes and at the sides, to allow of a passage through the economiser chamber. This greatly facilitates cleaning or examining the apparatus. The economiser being constructed from specially strengthened patterns is capable of working at high pressures. The scraper gearing is driven by a small special engine attached to the gearing frame of the economiser, which is made in one of Messrs. Green's special departments at their Wakefield Works. Patent access pipes are fitted to the bottom of the machine, this affording better means of cleaning out the bottom boxes. The water for the boilers is obtained from the river, and before passing into the boilers is pumped into a tank, and then goes through a water-softening apparatus made by the Maignens Filter Company. The height of the water in the tank is registered in the boiler house by one of Bailey's pneumatic gauges.



Accumulator Room.

Steam Piping.

The steam piping is not duplicated on the ring main system, as is usually the case, the engineers considering that it is quite as safe, and certainly more economical, to provide only one system of pipes, but to employ a high factor of safety, and to so design the piping that a repair can be carried out quickly. The steam piping is of T-welded steel, with steel flanges screwed on and riveted over. Inside diameter of pipe is 6 inches.



Engine and Dynamo Room.

Engines.

There are three of Marshall's coupled compound horizontal engines with cranks at right angles. High pressure cylinder is 11 inches diameter, low pressure 19 inches in diameter, and there is a 26-inch stroke; the fly-wheel is 12 feet in diameter, grooved for 7 1¼-inch cotton ropes, and is arranged to run at a speed of 116 revolutions per minute. The Proell governor controlling the valve gear has sufficient range to regulate the cut-off at any point up to five-eighths of the stroke. It is fitted with special adjusting gear so that the speed may be varied up to 5 per cent. either way whilst the engines are running. This is a point of considerable importance for many classes of work and enables the speed to be most accurately adjusted. The steam valves are of the double beat type and are fitted at the top of the cylinder with Proell's patent automatic double valve-releasing gear. All the working parts of this gear are case-hardened, and the cutting off edges are made of tool steel, hardened.

The exhaust valves situated at the bottom of the cylinders are of the Corliss type worked by separate eccentric. This method of working allows the finest adjustment both of steam and exhaust valves and is found to be superior to having all the valves worked off one wrist plate.

Each cylinder is steam jacketted with boiler-pressure steam, and between the two cylinders is a superheater or receiver. An auxiliary valve is fitted so that high pressure steam can be admitted into the low pressure cylinder for starting purposes.

Dynamos.

The dynamos are of the well-known Elwell-Parker type with three bearings, each bearing being fitted with oil rings giving continuous lubrication.

They are wound for 220 volts, 300 ampères, at 600 revolutions. The armatures are of the drum type with Crompton twisted wire bars, and Glover's solid copper ends, the end connections being of the usual semi-circular form. There are 152 bars on each armature, each of ·55 inch by ·275 inch cross section, the number of commutator sections being just half the number of bars. As the conductors are carried straight through to the arms of the commutator sections, the axis of commutation is approximately vertical. The pole-pieces of the field magnets are jointed on the centre line of the bore of the armature, so that the latter may be lifted out vertically instead of being threaded in and out of position endways. The magnets themselves are built up of slabs of soft wrought-iron 2 inches thick, cut off and rivetted together with the special tools laid down at the well-known Bushbury Works. The total cross-section of the field magnet circuit is 12 inches by 17 inches, each of the field coils being 20 inches long. The commutator is 10 inches diameter and 8¼ inches long on face, provided with three gauze brushes, 2⅛ inches wide, on each side. The machines are shunt wound, the winding being so arranged that the output may be 250 volts at 200 ampères for short periods for charging the accumulators. The machines were tested by Dr. Hopkinson at the Electric Construction Company's Works by the well-known method of coupling two machines together, the one providing current to drive the other as a motor, the latter the mechanical power to drive the former, a third machine being put in series with the armatures of the two machines to give the excess of potential required by the motor above that necessary for the generator. According to the contract, in the event of the pair of machines giving a greater efficiency than 84 per cent. the Corporation had to pay a bonus at the rate of £30 for every 1 per cent. by which the combined efficiency should exceed 84 per cent. As the efficiency came out at 88·1 per cent. (94·05 per cent.

for each machine), the amount of bonus due to the Electric Construction Company was £123, which added to the contract price of the dynamos brings the cost up to £1,274 for the three machines.

Switchboard.

The switchboard is made up of five panels, viz., two for the battery, one for the middle wire, and a plug-board for each of the outside wires. The board is split into two parts, about 10 feet long by 8 feet high, and 12 feet long by 8 feet high respectively. The slates are carried on porcelain insulators, and erected on a neat iron framing fronted with wood. It is fitted into an opening in the wall of the engine room, and having the repair shop at the back is just as accessible and well lighted behind as it is in front. This is a point which is overlooked in some stations.

The plugs are of gun-metal, all interchangeable, the threads on the bars and plugs being so cut away that the plugs may be brought home with one quarter turn. The switches have laminated brush contacts, and give a double break. All cables are connected to the bars by cone connections, hexagonal box spanners being supplied to tighten up the cones. The plugs and switches are actuated by square box spanners with insulated handles, fitted with a spring catch to hold the plugs during removal.

The battery panels are each fitted with one charging and two discharging switches, one of the latter being connected to a Kelvin electrostatic voltmeter. Each switch is capable of carrying continuously 200 ampères, which will be the normal current. They are arranged to put in or take out 19 cells by steps of one cell at a time, and are so constructed that when the switch arm is moved the circuit shall not be opened nor a cell short-circuited. Each panel has a 19-way switch connected with a suitable cell testing voltmeter.

The middle wire panel is provided with a bar connected to the centre of the battery, and also an ampèremeter capable of reading correctly to 150 ampères, and also denoting in which direction the current is passing. This panel is also provided with two change-over 50 ampère switches, with two suitable ampèremeters to read to 50 ampères. The switches and cut-outs for the station circuits, and also two Kelvin electrostatic voltmeters, are on this panel.

The two plug-board panels are arranged to carry 600 ampères one hour without injury. The ampèremeters read to 300 ampères correctly, and also indicate a reverse current, with its direction, for the purpose of throwing machines in and out. The resistances for the dynamos are on these panels. The whole is finished in a high class manner, but there has been considerable delay in getting it completed.

Accumulator Room.

This room is on the second storey, and has an acid and waterproof concrete floor. The cells are mounted on an angle and Channel steel framework; the immediate supports under each cell are of oak. The whole is protected with Griffith's enamel acid-resisting paint. The batteries were made by the Chloride Electrical Storage Syndicate at their works at Manchester. There are 112 cells altogether, each cell containing 29 plates, 11 inches by 11 inches, the total capacity being 267 ampères for 3 hours.

The cells are of pitch pine lined with lead, they are considerably longer than is necessary, but this is done purposely so that the number of plates in each cell may, at some future time (when exigencies demand it), be increased. The plates are separated by asbestos cloth, and are squeezed tight against each other by four ebonite bolts $\frac{1}{2}$-inch diameter, fitting through ebonite blocks laid against the two outside plates. These bolts and their nuts, although of ebonite, are very neat, and the threads look as though they would stand a good deal of wear before stripping. Another improvement is the keying of all the plates both at the top and bottom edges by means of two sheets of plate-glass which go along each side of the cell.

The plates are made up of tablets of fused chlorides of lead and zinc held together by a frame of antimonious lead. This frame is cast round the tablets, which are slightly larger at the middle than on the two outsides, it is, therefore, obvious that the active material is held much better than by the old methods. The plates are "formed" by withdrawing the zinc chloride by simple solution and also the withdrawal of the chlorine of the chloride of lead by fixing it in combination with the zinc to form zinc chloride. When the process of disintegration is complete, and all the chloride of zinc is washed out, a mass of crystallised metallic lead is left which is suitable for immediate use without the "forming" process of Planté, and without the application of any active material, or material about to become active, by the processes of Brush and Faure.

According to the terms of the contract the Chloride Company have to keep the battery in perfect order for a period of three years.

Pump Room.

The engines are arranged for condensing, each one being fitted with one of Korting's patent ejector condensers, these condensers being worked by a head of water supplied from

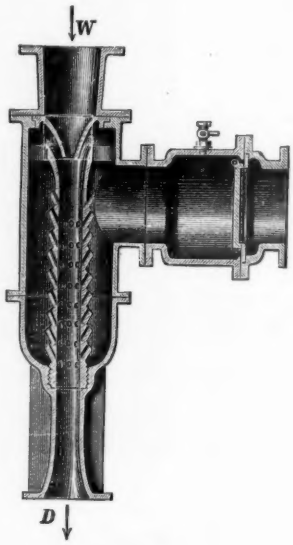


Fig. 1.

an overhead tank, the wash running direct to the river. The tank is kept supplied by two of Gwynne's centrifugal pumps driven by Gramme wound electric motors or by one steam

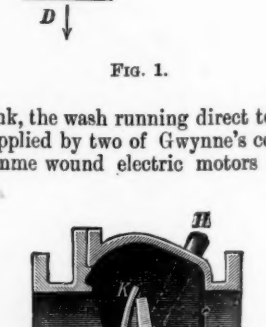


Fig. 2.

pump by Pearn & Co. All these pumps, &c., together with the two boiler feed pumps, are situated in a separate house, thus keeping this part of the installation entirely separate from the engines and dynamos.

Condensing Room.

The condensers are under the floor of the engine houses, each condenser being under its respective engine. A three-way valve enables the engine exhaust to be turned on to the atmosphere or into the condenser.

The Korting condenser and its non-return valve is shown by figs. 1 and 2 It will be seen that it belongs to the class of spray condensers in which the exhaust steam comes in direct contact with the condensing water. In the case of the ordinary spray condenser an air pump, usually driven direct from the engine, is used for the discharging of the water and air, and the power absorbed by this pump partially neutralises the increase of power secured by the vacuum. With the ejector condenser the

exhaust steam itself supplies the energy required for the expulsion of the water and air. The condensing water is introduced as a solid cylindrical jet into the vacuum chamber, where it is surrounded by the exhaust steam from the engine. The steam impinging on the surface of the jet imparts to it a high velocity, and the momentum thus acquired carries the water and air out at the discharge end of the apparatus. A vacuum of 12 lbs. per square inch may be thus obtained by a very simple and cheap piece of apparatus.

Electric Mains.

The mains are all supplied by Messrs. Siemens Bros. and Co. They are vulcanised India-rubber covered, and are drawn into Doulton sanitary pipes, there being a pipe for each of the three mains. The pipes entering the distributing boxes are formed with bell mouths to prevent abrasion of the cables. The conductors are protected by a strong braiding, and each—positive, intermediate, and negative—cable is distinguished by a colour, the neutral wire being about ·6 of the section of the two outer ones. All the drawing-in junction and distribution boxes are built of brick, drained but not ventilated. The house service cables from the distributing mains are connected by solid T-joints, insulated with India-rubber compound; these joints are made in brickwork boxes covered by stone slabs, the position of each such box being distinctly marked on the wall of the premises into which the leads pass.

Circuits.

As only the centre of the town is to be supplied, the mains are laid in a network with three feeders, the feeders being connected at the following points:—(*a*) Market Square; (*b*) Junction of Greengate Street and Tippings Street; (*c*) Martin Street, opposite the County Council Hall. The cables are large enough to take current for 5,000 16-candle-power lamps in order to avoid further disturbance of roadways or pavements for some considerable period. The cables will be extended from time to time as the demand for current increases, until they are spread over the whole borough. At the present time there are about 30 customers connected, representing some 1,500 lights. It is anticipated that a great many more applications will be received when the lighting season commences. The charge for current is 8d. per unit (gas is 2s. 3d. to 2s. 9d. per thousand), but Wright's demand indicator is to be used, so that all current supplied after the first 1½ hours will be charged half price, or 4d. per unit.

Quite a number of large public buildings have just been completed or are now being erected, including the County Council Hall, Technical School, and Infirmary. As these are to be wired, the full load of the station, 3,500 16-C.P. lamps, will probably be reached in the first season's running. Mr. Ferguson-Bell has had the corporation's workmen doing some of the small installation work, about 20s. per lamp being charged. All the wire is arranged not to carry more than 750 ampères per square inch, and the minimum insulation has to be 2 megohms for 25 lamps and ½ megohm for 100 lamps.

Detailed Costs.

	£
Site	500
Buildings	2,461
Chimney stack	570
Boilers	1,138
Meldrum dust fuel furnaces	200
Boiler mountings	93
Economiser	340
Engines	2,420
Steam piping	200
Dynamos with bonus	1,274
Tightening rails	40
Switchboard	500
Accumulators and stand	890
Electric mains and services	1,600
Exhaust pipes and overflow mains ...	75
Overhead traveller	185
Water softener	220
Iron roofing	200
Feed pumps for boilers	220
Steam injectors	30

Although the time taken to complete the work has been longer than was expected, the whole thing strikes one as being done in a very satisfactory and substantial way. The Stafford Corporation are to be congratulated on being among the first few municipalities in the country which undertakes the supply of both gas and the electric light. The governing body of this county town at any rate are fully alive to modern requirements. Although at present the streets are not to be lighted, the electricity committee are fixing up as an experiment two Brockie-Pell 12-ampère arc lamps in Gaol Square.

NEW PATENTS—1895.

437A. "Improvements in and connected with arc lamps." J. B. Barton. (Communicated by W. Jandus, United States.) [Date claimed under Patents Rule 19, January 7th, 1895.] Dated September 11th.

16,826. "Improvements in the electrolysis of saline solutions." E. Andreoli. Dated September 9th.

16,842. "Improvements in extracting zinc from mixed sulphide ores and the like." T. Parker and J. Pullman. Dated September 9th.

16,843. "Improvements in the extraction of gold and other metals from refractory ores." T. Parker and J. Pullman. Dated September 9th.

16,866. "Improvements in arc lamps." E J. Piper. Dated September 10th.

16,897. "Improvements in holders and supports for electrical candles." H. Hirst and W. E. Gibson. Dated September 10th.

16,898. "An improved wall socket and plug for electric lighting and kindred purposes." G. Binswanger. Dated September 10th.

16,910. "Improvements in and relating to power transmitting mechanism for the power shafts of electric and other high speed motors." D. S. Regan. Dated September 10th. (*Complete.*)

16,918. "An improved junction coupling for electric lighting installation." H. A. Cutmore. Dated September 10th.

16,924. "Improvements in electric fire alarms." C. D. Tisdale and J. D. Gould. Dated September 10th. (*Complete.*)

16,925. "Improvements in electric fire alarms." C. D. Tisdale and J. D. Gould. Dated September 10th. (*Complete.*)

16,939. "Improvements in electric locomotives." J. Devonshire. (Communicated by E. W. Rice, jun., United States.) Dated September 10th. (*Complete.*)

16,940. "Improved electrical tool." F. J. Warden-Stevens. Dated September 10th.

16,950. "Electrolyte baths, appliances, and system." J. H. George. Dated September 10th.

16,952. "Improvements in incandescence electric lamps." W. Rowbotham and H. Levetus. Dated September 10th.

17,004. "Improvements in and in the method of constructing incandescent electric lamps." P. R. J. Willis. (Communicated by R. Greer, United States.) Dated September 11th.

17,044. "Improvements in extracting gold, silver, and other metals from ores and the like." J. B. Torres. Dated September 12th.

17,058. "Improvements in periodically ringing bells and sounding whistles, syrens, and the like, and registering the same, and in electrical apparatus therefor." F. H. Berry. Dated September 12th.

17,063. "Improvements in electric smelting." T. L. Willson. [Date applied for under Patents, &c., Act 1883, Sec. 103, February 20th, 1895, being date of application in United States.] Dated September 12th.

17,123. "Improvements in linked suspensions for electroliers, electric light pendants and the like." H. Hirst. Dated September 13th.

17,205. "Improvements in machinery or arrangements for lifting, lowering, carrying or transporting loads, actuated by electricity." J. A. F. Aspinall. Dated September 14th. (*Complete.*)

17,210. "Improvements in the manufacture of electrical resistances." A. J. Marquand, E. Hancock, and D. Lowdon. Dated September 14th.

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1894.

14,113. "Improvements in meters for recording the consumption of electrical energy supplied at differential rates." A. G. Cooper and the British Thomson-Houston Company, Limited. Dated July 23rd. Consists in the use of a divided or separate winding in the meter to register currents which are charged at different rates, so as to do away with a second meter, where lighting, for instance, and power, are charged at different rates. 2 claims.

14,488. "Improvements in or connected with electric arc lamps." J. Jeffreys and J. Lea. Dated July 27th. Consists in placing the regulating train at the end of the carbon holder rod and making the rack a fixture in the body of the regulator, said rack being in gear with the first pinion or tooth wheel, so that when the arc making solenoid or electromagnet allows the clutch to separate the carbons and form the arc, it causes the clockwork to be set in motion preventing it being done too quickly, because the whole of the regulating train has to turn. 4 claims.

16,916. "An improved apparatus for manipulating lime and electric lights, and the boxes used therewith. H. Taylor. Dated September 5th. Consists in providing mechanism, whereby one or more lime or electric light boxes situate at any part of the stage, platform, or room, may be conveniently and easily manipulated by one person standing at any other part of the stage, platform, or room. 5 claims.

17,378. "Improvements in direct current transformers. A. B. Blackburn and T. L. Boyden. Dated September 12th. The transformer constructed according to this invention has four or more poles, the conductors of the low tension portion of the armature are arranged in multipolar parallel winding, in which the whole number of conductors round the periphery is divided into sections depending on, and divisible by, the number of pairs of poles, each section being available to produce the full low tension electromotive force, the current being collected by separate brushes from each section, those of similar sign being connected in parallel and to their proper terminal. 2 claims.

18,177. "Improvements in electrically actuated brakes and belt shifting devices." P. Auguste Godchaux. Dated September 25th. This disengaging, which forms one of the characteristics and important parts of the invention, is extremely simple, and in addition its action is instantaneous and very powerful. 4 claims.

18,196. "Improvements in current collectors for overhead electrical conductors." Siemens Brcs. & Co., Ltd. (Communicated from abroad by Messrs. Siemens & Halske, of Berlin. Dated September 25th. The collector rod is jointed to a horizontal lever arm, which is mounted on the vehicle so as to lie longitudinally. From the rod, at its lower end where it is jointed to the lever arm, project two short arms, the one inclined a little upwards and the other equally inclined downwards, and these are connected by slotted links to a spring, so that the collector rod, when free, is held by this spring in a vertical attitude, but can be inclined to the one side or the other of the vertical. The lever arm to which the rod is jointed is free to move a certain distance up and down between stops, and is held up by a spring of sufficient strength to support the weight of the movable parts, and to give the collector a certain amount of pressure against the wire. In order to steady the appliance laterally, the lever arm is duplicated, consisting of two parallel arms, the rod is also duplicated as well as the springs. 4 claims.

18,273. "Improvements in electric motors." J. Imray. (Communicated from abroad by La Société Anonyme pour la Transmission de la Force par L'Electricité, of Paris.) Dated September 26th. An outer armature consisting of an even number of bobbins presenting their poles, which alternate in polarity, inwards towards internal fields, as it revolves, tends to produce two fluxes of constant intensity turning in opposite directions around the axis with a certain velocity. When one of these fluxes is suppressed the other acts in aid of the motor. This suppression is effected by interposing between the armature and the internal fields a hollow cylindrical screen consisting of thin sheet iron layers insulated from each other, mounted so as to be free to revolve. When the armature revolves this screen revolves with it in accord with the one flux, effecting suppression of the opposite flux. 2 claims.

21,838. "New or improved process for electrolysing chemical combinations and winning the products of decomposition formed by the electrolysis." W. Bein. Dated November 12th. The process is based on the following principle:—The products of decomposition formed in the electrolysis of a conductive solution will remain near to the electrodes as long as the current is passing through the solution, but no longer; if diaphragms are not employed, and if suitable arrangements are made at the electrodes to prevent purturbation in the solution through the sinking or rising of the said products formed, owing to variations in the amount of their specific gravity, or by rising gas bubbles, or owing to sudden local rises in the temperature, &c., the products of decomposition thus collecting at the electrodes will be separated by the layer of unchanged liquid lying between them. 1 claim.

1895.

52. "Improvements in electric lighting apparatus for railway cars." W. Biddle. Dated January 1st. Relates to the use of a polarised compound switch, the object of which is primarily to direct the current so that it may reach the field helices and the secondary battery in a uniform direction or polarity, and the secondary object of such polarised compound switch is to break the electric circuit when the speed of the car has lessened, so that the electric energy developed by the dynamo has reached a minimum voltage, and becomes less than that of the secondary battery. 5 claims.

2,430. "Improved means for insulating electric conductors." G. G. M. Hardingham. (A communication from the firm of Felten and Guilleaume, of Mülheim-on-the-Rhine.) Dated February 4th. A tube enclosing an air space and conductor is triangular, quadrangular or polygonal in cross section, and is twisted longitudinally. 4 claims.

2,914. "Improvements in systems of electrical distribution." J. Devonshire. (A communication from abroad by C. P. Steinmetz, of Schenectady.) Dated February 9th. Comprises a set of mains connected to and supplied by a source of single phase alternating currents, and associated with this set of mains one or more balance wires on which is maintained an electromotive force out of phase with the electromotive forces on the single phase mains. 14 claims.

4,120. "Electric heaters for applying artificial heat to the human body, and also for the purpose of artificially heating apartments, cars, furniture and such like." J. E. Meek. Dated February 26th. Consists in interposing an electric conductor in the form of a wire or thin strip of metal, between threads or yarns of any suitable non-conducting material, preferably asbestos, in such manner that the threads or yarns shall separate and insulate the adjacent parts of the conductor from each other, and also from exterior contact. 11 claims.

4,257. "Improvements in or connected with electric arc lamps." W. P. Thompson. (A communication by W. A. R. Mathiesen, of Leutzsch.) Dated February 27th. A diminution of the quantity of air flowing to the arc is obtained by a bell or globe which encloses the bars of the lamp, and is of suitable form and size, being so far rendered air-tight that only a quantity of atmospheric air necessary for ensuring the steady burning of the arc is admitted, whilst the exhausted air escapes, together with the gases of combustion, at suitable places. 7 claims.

4,610. "Improvements in or relating to secondary batteries or electric accumulators." W. A. Boese. Dated March 4th. Consist, first, in dissolving, in place of the residues of tar distillation mentioned in the process described in patent No. 11,532, June 20th, 1892, certain other bodies of definite chemical composition, in alcohol, ether, or benzol, and then employing such solutions for mixing with the mass of the lead oxide. 1 claim.

5,331. "Improvements in recording wattmeters." J. Devonshire. (A communication from abroad by W. C. Fish, of America.) Dated March 13th. The object of the present invention is to provide an improved meter, by means of which very large currents may be measured; such, for instance, as represent the entire output of a dynamo at the central station, while securing, at the same time, accuracy in registration, economy of construction, and an apparatus which can be easily installed. 7 claims.

5,428. "Electric transmitting thermometer." F. N. Denison. Dated March 14th. Consists, essentially, of a thermometer, the tube of which is provided throughout the greater portion of its length with a manganese steel conducting wire, or other suitable high resistance conductor centrally located in the tube, and having conducting wires, one passing from the top of the high resistance wire through the tube, and the other connected to the bottom of the wire and passing out laterally through the tube, the conducting wires and thermometer being encased, and the wires leading off to a suitable indicator, preferably through a cable, which is used to support the thermometer. 7 claims.

5,701. "Improvements in electric arc lamps." G. R. MacIntire. Dated March 19th. Relates to a lamp provided with a plurality of pairs of carbons, the feed of which is controlled and determined by a single set of feeding mechanism. 5 claims.

6,007. "Improvements in controlling apparatus for electrically propelled railway trains." Siemens Bros. & Co., Ltd. (Communicated from abroad by Messrs. Siemens & Halske, of Berlin.) Dated March 22nd. Claim: A controlling apparatus for electric railway trains wherein longitudinal controlling shafts are coupled together in such a manner as to allow freedom of lateral motion, the controlling operation being thus effected simultaneously for the whole train from any one car, substantially as described.

7,086. "Electric switch." G. W. Russell, jun., and A. V. Officer. Dated April 6th. Relates to improvements in automatic electric switches for use in connection with a direct or alternating current, whereby the circuit may be closed or broken through the instrumentality of push buttons. 7 claims.

7,625. "Improvements in electric wire insulators." D. M. Rothenberger, C. A. Inglis, and E. D. Reilly. Dated April 16th. The object of the invention is to provide a simple, cheap, but strong insulator in construction and convenient of manipulation, by providing the insulator itself with an external groove or recess to receive the main wire, and an inwardly extending opening having its outer end opening into and communicating with the said external groove, the said opening being formed to receive a tie wire to be held or secured in the said opening by means of solder or plastic material; and to preferably provide the opposite end of the insulator with a means of attachment to a wall or other hold. 7 claims.

7,649. "Improvements in and relating to electric arc lamps." E. H. Crosby and O. M. Shaw. Dated April 16th. An especial object of the invention is to produce a portable arc lamp adapted for use on an incandescent circuit, and provided with an automatic feed for the carbons whereby the flickering incidental to ordinary lamps of this class is prevented. 7 claims.

7,668. "Improvements in systems of electric distribution." J. Devonshire. (A communication from abroad by E. W. Rice, jun., of Massachusetts.) Dated April 16th. Consists in distributing continuous current over the mains by ordinary methods, all of the mains of like sign being connected as commonly practised, and to connect various points of this extended distribution system by alternating current lines, establishing at the ends of such lines motor-generators adapted to convert the current from alternating into continuous. 8 claims.

8,834. "An improved system of electric traction." O. Lindner and C. van Sweevelt. Dated May 3rd. Consists in the use of an automatic running communicator which communicates or transmits the electric current from a cable, wire, or other suitable conductor to the electric motor driving the car or its equivalent, the said automatic running communicator being located in a closed channel in the permanent way. 3 claims.